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IN MEMORY OF OUR

MOST GRACIOUS PATRON

HIS MAJESTY
KING GEORGE V,

WE take this opportunity of expressing our profound grief at the passing of one who always followed with the greatest interest the progress of agricultural research and the development and prosperity of Tropical Agriculture throughout the Colonial Empire.

DEFORESTATION IN THE WEST INDIES.

CONSIDERATION has already been given in this Journal to the problem of deforestation which is concomitant with that of soil erosion and which, in many parts of the world, may be regarded as of utmost importance. For years, the process of destroying vast areas of forest and replacing these by cultivation has been going on, without thought, in many instances, for the future. As a consequence tremendous damage has been done; witness the loss of huge quantities of valuable soil, the wastage of timber, the denudation of hillsides, the occurrence of destructive floods and the silting up of streams and reservoirs. In tropical countries, soil erosion, which may be regarded as largely responsible for the deterioration of soil fertility, proceeds more rapidly than in temperate regions, since it is accelerated by climatic factors, such as torrential rains and extreme heat, and by primitive methods of cultivation. The study of the problem in our tropical dependencies thus becomes of paramount necessity and it is significant that in the last few years considerably more attention has been paid to it than hitherto.

In the West Indies, the question of deforestation has recently been the subject of renewed investigation by the Chief Conservator of Forests of the Madras Presidency. This official, who was seconded by the Government of India to the Colonial Office for special duty in this connection, called recently at Trinidad on his way from Jamaica where he had been sent to enquire into the causes of the rapid deforestation that has taken place in that Colony and to advise on necessary measures of control. He has also visited the Windward and Leeward Islands for a similar purpose. As far as Jamaica is concerned the position in regard to forest denudation is said to be particularly serious and to be complicated by the fact that much of the land is privately owned. Now that the seriousness of the situation has been brought home, however, special efforts will no doubt be made to deal with it. In the Windward Islands, forestry conditions are perhaps somewhat better, but in many of the Leeward Islands deforestation has proceeded so rapidly in the past that practically no forests now exist.

In 1932, when Marshall [1] reported on the forests of Grenada he described the position as highly unsatisfactory and recommended that in the interests of agriculture, additional areas, mainly of mountain land should be reserved and means devised to keep these permanently forested. He drew attention, amongst other things, to the lack of provision that had been made for keeping the sources of a number of rivers under forest; to the promiscuous manner in which shifting cultivation was being carried on, except on some estates where the ridges were kept forested; and to the fact that practically no attention had been paid to the retention of forests as windbelts.

Conditions in St. Vincent are fairly typical of those obtaining in some of the other islands where forests have not yet been obliterated. The central range of mountains above a certain contour level (1,000 feet) has been scheduled by special ordinance as Crown lands and is supposed to be reserved as forest in order to protect the sources of springs. Owing to lack of staff and therefore of the necessary supervision, it has been found difficult to control squatters from clearing areas inside the forest boundary and immediate action will need to be taken to stop further encroachments if the flow of water in the various streams that arise in this "massif" is to be maintained throughout the year. This forest reserve is of particular importance to St. Vincent as the staple crop, arrowroot, demands a good supply of clean water for its manufacture in the dry season.

Trinidad has been wiser than many of her sister Colonies in the reservation of protective forest areas. In the past few years, however, deforestation has been proceeding apace in the centre and western part of the Northern Range of hills. If this is allowed to go on it can but lead in the end to disaster. With the removal of forest cover, which at first was more or less confined to the lower slopes but which now has been extended to the summits of some of the hills, damage has already been occasioned by the drying out and erosion of the soil, by shortage of waters in the springs and streams during periods of fair weather, and by extensive floods during periods of heavy rainfall. The very severe floods which occurred recently in the Maracas Valley and in the Caroni plain must in a large measure be attributed to the rapid and unchecked flow of waters down the denuded hillsides of the Northern Range. It is obvious therefore that any further undue interference with the forest canopy of these hills will result in more extensive damage being done to agricultural undertakings in the lowlands. Agriculture on the upland regions has already been affected. Much of the soil where patches of forests have been burnt for making gardens, which after a year or two have been abandoned, is practically useless. Where forest windbreaks have been removed, some of the cacao plantations have also suffered; the even humidity which cacao requires has been upset and arid periods occur. Considerable damage to roads and property has been done also by landslides on the steeper slopes. The process of deforestation has undoubtedly been accelerated by the depression in the cacao industry since planters have resorted to the policy of encouraging peasant gardens with the object of keeping their skilled labour on the spot; this results inevitably in shifting cultivation owing to the rapid deterioration of the thin soil present on these steep hillsides. At the same time, the very grave dangers of deforestation cannot be overlooked, and steps have already been taken by the Trinidad Departments of Agriculture

and Forestry to deal with the situation. It has been urged that no further land should be alienated on the slopes of the Northern Range without the joint sanction of the Director of Agriculture and of the Conservator of Forests. Propaganda is to be inaugurated with a view to inducing the larger estate owners to prohibit shifting cultivation on their estates and consideration is being given to asking Government to vote a sum of money annually for the acquisition of land from small proprietors in zones of particular danger.

Our local problems of deforestation illustrate the point that " too little thought is often given to effects which result from the utilization of lands for agricultural purposes in catchment areas ", the catchment areas in this case being that of the Caroni river. Up to the present it has not been sufficiently realized that " the alienation or utilization of such lands ought only to be permitted after the most careful investigations have been made " . . . " Important catchments should, of course, always be left protected by their forest cover in prescribed forest reserves, and agricultural operations should not be permitted in the less important catchments unless adequate measures are taken at the same time to safeguard important springs, to maintain stream reservations, and to check soil erosion " (2). Destruction of the forest cover is easy: the reafforestation of denuded areas, especially in the tropics, is often technically difficult and expensive. All of this is applicable to our problems here, and probably also to those of other parts of the West Indies. The menace of soil erosion cannot be overstressed. Much of the work against it has been left to agriculturists and forest officers but it really deserves the widest possible consideration from everyone interested in the welfare of agriculture and the preservation of land for future generations.

References.

(1) R. C. Marshall. Report on Forestry in Grenada 1932.

(2) F. A. Stockdale.—Forestry in relation to Agriculture under Tropical conditions. British Empire Forestry Conference, 1935.

OBITUARY.

The Hon. Carl de Verteuil, C.M.G.

By the death of the Hon. Carl. de Verteuil, on the 31st of January, Trinidad has lost one of her most distinguished sons, and the Imperial College of Tropical Agriculture one of its most valued counsellors.

Born in 1857, of one of the several families of French descent who had taken part in the development of the sugar industry, he received his early education at St. Mary's College, Port-of-Spain, and at Ushaw College, Durham. When the time came for him to choose a career, the prosperity of the sugar industry was already on the wane, and he elected to study engineering and surveying at the University of London. Thus it came about that on his return to Trinidad in 1879, as a young man of 22, Mr. de Verteuil was employed on the construction of the railway to San Fernando. His interests, however, clearly lay in agriculture, and after managing his mother's cacao estate at Maracas Bay for a time, he acquired a few small cacao holdings of his own in the Montserrat District, to which district he went as road officer. By 1896, the increasing claims of his growing estate induced him to take up residence at La Vega, which remained his home for nearly thirty years. In 1925 he removed to Port-of-Spain, but continued to take a lively interest in his country property. He had played his part as a pioneer in the modern development of the Trinidad cacao industry and lived to witness its decline.

Carl de Verteuil was not a man to be content with merely owning a cacao estate. From the first he took a keen interest in the scientific aspects of planting, and his contributions to various agricultural conferences and publications reveal unusual powers of observation. La Vega was always open to scientists, of whom several generations will recall with pride and pleasure the enthusiastic co-operation and generous hospitality of its genial proprietor. It was therefore natural that the College should find in him one of its most loyal supporters, and fitting that he should have been one of the sponsors of its Cacao Research Scheme, though he realized, with a regret that we all shared, that he would not live to see the results of the latter undertaking.

As an example of co-operative effort, the Cacao Planters' Association of Trinidad and Tobago has excited the admiration of experts from many countries. The development of this organization into the most important exporter of cacao from Trinidad was due in a large measure to the untiring and unselfish efforts of Mr. Carl de Verteuil, one of the moving spirits in its formation and for many years its Chairman.

To the public life of the Colony he likewise gave of his best. On the Legislative Council he served for many years from his first appointment in 1905. His advice was indispensable to every Committee appointed to consider the welfare of the cacao industry, and advantage was taken of his ripe experience by his appointment to the Executive Council in 1931. None has served his country more faithfully, and it was characteristic of the man that he remained active in all his many public interests until the very day that his last brief illness overtook him.

The Hon. Carl will be missed by a wide circle of friends, within and without the island of Trinidad, but by none more than by the staff of the Imperial College of Tropical Agriculture. The charm of his personality lay largely in its happy combination of generosity in deed and word with a shrewd perception of real values. He combined modesty, sympathy and humour with great moral courage. Injustice, hypocrisy, and anything mean alone ruffled his habitually kindly demeanour and gave a key to the strength and integrity of his character. We admired the agriculturist, and profoundly respected the public figure, but the man himself we loved.

ANCIENT AGRICULTURE.

THE popular account of the excavations made recently at UR given by C. Leonard Woolley* who was in charge of the work, contains some information about agricultural methods over 5,000 years old which are worthy of the attention of students of today.

The history of UR, as revealed by these excavations, goes back beyond the Flood. Evidence was found of the truth underlying the tradition of the Flood extant among many races. In the dim past, before the Flood, the lower end of the Euphrates Valley was a great marsh through which two rivers made their sluggish way to the sea. Gradually these streams brought down more and more silt, as such streams do to this day, and the marsh began to shrink until dry land appeared. Then, from the uplands of Arabia, settlers drifted down and occupied such islands as gave them a chance to cultivate the rich alluvial soil as soon as it was free from water. One of these islands was UR, and here the remains of this primitive occupation have been unearthed, remains which show that these people cultivated the soil, reaped harvests of grain, kept domestic cattle, sheep, and goats, and fished in the marshes. They were a primitive people it is true, but had made some advance on the road to civilisation.

This settlement must have lasted for a very long time, until at a date which cannot be fixed, people of a new race made their way into the valley and settled down side by side with the old inhabitants. These were the Sumerians who had reached a high degree of civilisation, a knowledge of agriculture, the working of metal, and the art of writing. At UR the new comers built a town and the original inhabitants became their serfs. Many generations of this mixed population passed, and then came the Flood which is mentioned in their writings.

The excavations revealed the presence of a great bed of clay eight feet thick. This bed of water-laid clay which could only have been the result of a flood of a magnitude unparalleled in local history marks a definite break in the continuity of the local culture. A whole civilisation which existed before it is lacking above it and seems to have been submerged in the waters. This deluge was not, however, universal as legend has it, but a local disaster confined to the lower valley of the Tigris and Euphrates, affecting an area of some 400 miles long and 100 miles wide. For the occupants of the valley that was the whole world. The primitive peoples were wiped out, but some of the Sumerians who lived on higher levels survived and were able, not only to develop their own civilisation uncontaminated, as the excavations prove that they did, but also to advance northward and occupy the empty lands.

The date of this inundation is uncertain, but it was certainly before 3200 B.C. For some 2,500 years this civilisation continued until, in the Persian period about 500 B.C., another disaster occurred. In the old days the river Euphrates washed the walls of UR on the west and from it innumerable canals led the water off into the fields, and up and down these canals passed ships from the Persian Gulf. Today the Euphrates runs ten miles to the east of the ruins of UR, and the great plain once cultivated and irrigated is now a barren desert. The exact time when the river changed its course is not known, but the drying up of the old bed meant the ruin of the whole elaborate system of irrigation, and the end of agriculture. Gradually the inhabitants deserted the town, the houses crumbled, and the winds sweeping across the now parched and dessicated level brought clouds of sand which buried the city which soon became a wilderness of brick-littered mounds. Truly a picture of soil erosion on a grand scale.

Among the many interesting relics which have been unearthed during the excavations on the site of UR is a mosaic frieze showing a procession of cows. On one side of a reed-built byre, from the door of which two calves are seen issuing, men seated on low stools are milking cattle. The man sits under the cow's tail milking the animal from behind. The calves, duly muzzled are roped to the cow's headstall so as to encourage her to give milk. On the other side of the byre two men, clean shaven and wearing the fleece petticoats, the official dress of priests, are pouring milk through a strainer into a vessel set on the ground, while two others are collecting the strained liquid into great stone jars. This frieze is said by the experts to represent a scene at a farm attached to a temple, a farm dating about 3100 B.C. employing dairying methods which will repay comparison with methods used today all through the tropics.

Another find of interest to students of agriculture was a small statue representing the Goddess Bau, seated on a throne supported by geese. Bau was the patroness of the poultry farm, and her figure in a flounced and pleated dress reaching to the ankles, square and thick set, has an appropriately domestic look. Unfortunately the author does not give us an illustration of the statue.

R. D. A.

* Ur of the Chaldees, by C. Leonard Woolley. The Faber Library No. 28.

SOIL EROSION IN KENYA.

By S. F. Deck.
(*Formerly Senior Commissioner, Kenya Colony.*)

Of recent years various commissions have investigated the problem of soil erosion and denudation both in South and East Africa. In 1929 a commission under the chairmanship of Sir Daniel Hall attributed erosion in the native reserves of Kenya to the destruction of shrubs and young trees on the higher ground by the ubiquitous goat. The report states that to the goat more than anything else may be attributed the deforestation of Greece and other Mediterranean districts where the soil has been completely washed away, creating on the one hand bare hillsides, and on the other, swamps in the valleys.

The South African Economic Commission of 1932 reported that in the Native Reserves of the Union, with few exceptions, the carrying capacity of the soil, both for humans and livestock, is on the down grade, and that unless the present state of affairs is soon remedied there will be in the Union, within one or at most two decades, an appalling problem of human poverty.

The Morris-Carter Commission (Kenya 1933) discusses at length the same problem as it affects the Suk, Kamasia and Machakos districts in Kenya. In the Suk district, owing to over-stocking, the grass has entirely disappeared over large areas, giving way to a growth of dense thorn scrub which absorbs all moisture and prevents the growth of grass. In the Machakos Native Reserve the report states that the land is rapidly deteriorating owing to over-stocking; and that in the Suk, Njemps and Samburu districts the natives appear to show no regard for the ruination which is going on before their eyes, but devote their lives to amassing large herds of uneconomic livestock which are fast turning their country into a desert. In West Africa also the danger has been recognized. Recent investigations show that owing to faulty land management, valuable agricultural land in French and British Nigeria is being absorbed by the Sahara desert at a rate estimated to exceed a kilometre a year. Professor Stebbing states that the Sahara has advanced 300 kilometres southward in three centuries.

It is well known that in Northern Africa what is now desert was once fertile country, carrying a large and highly civilized population.

In Kenya the Machakos district of the Ukamba Native Reserve provides a good example of rapid erosion and deterioration through over-stocking. This district, lying on the eastern edge of the Kenya Highlands was first occupied and administered in 1889 by the Imperial British East Africa Company. The total area of the district is 2,166 square miles and the population is 239,000 or about 110 per sq. mile. The people are mainly pastoralists, but about 140,000 acres are estimated to be under cultivation, the main crops being millet, beans and sweet potatoes. The rainfall in the western part of the district, where most of the population is concentrated, averages about 30 inches per annum. The average elevation is about 5,000 feet above sea level, but the district is intersected by lofty mountain ranges some of which rise to an altitude of 7,000 feet or more. The geological formation consists mainly of schistose rocks the detritus of which provides a fertile soil which, with reasonable treatment, can produce excellent crops and grazing; but it is not a strong soil and does not stand up well to hard wear and tear. The natives live in small groups and the average village does not contain more than a dozen huts, *i.e.*, about four or five families. The average number of cattle per family is five and of sheep and goats 6½. At first sight this would not appear an unreasonable allowance; but, according to the report of the Carter Commission, it means that 100 acres of land have to maintain 20 cattle and 30 sheep and goats; whereas the District Veterinary Officer in his evidence before the Commission estimated the carrying capacity of the district in its present condition at one head of cattle to 30 acres, without sheep and goats. That is to say the district is carrying about six times the number of cattle it can reasonably accommodate, in addition to some 300,000 sheep and goats. Sales to outside markets do not exceed 20,000 head of cattle per annum, and of recent years the cattle have deteriorated both in size and milk yield.

The denudation and soil erosion which are rapidly turning this once fertile district into a semi-desert are of recent occurrence. When the district was first occupied and administered in 1889 the cattle throughout Eastern Africa had been decimated by rinderpest, numbers were few and grazing ample. The population was smaller and the forests on the high mountain ranges were still intact. They served as places of refuge for the natives when threatened by marauding Masai. But with the establishment of *Pax Britannica* inter-tribal raids have ceased and veterinary services have protected the cattle from disease. The area under cultivation has increased and with it the forests on the high ranges have vanished, with the exception of a few sacred groves to which the natives still hopefully repair to pray for the restoration of the soil fertility which they themselves have, all unwittingly, destroyed. The hillsides, scarred and furrowed by innumerable stock tracks are now not only treeless but grassless; and in many places, successive rainstorms have converted the furrows into deep dongas, down which the soil is washed into the valleys until the bare bones of the hillsides are exposed.

In some countries the soil washed from hillsides is deposited further down the valleys in the form of alluvial flats on which crops may be grown. Unfortunately for the Machakos district the ground falls too steeply to permit of such accumulations. The eroded soil travels down small mountain stream beds into the deep and rocky valley of the Athi River which carries it rapidly to the sea.

Every hillside cattle or goat kraal has become a focus from which the forces of erosion are set in motion. Stock tracks radiating from the kraal gradually furrow the friable soil which is rapidly carried away, not only by rain but also by the high winds which prevail through the long dry seasons from July to November and from January to March. Even the cattle droppings around the villages, which might be expected to stimulate the growth of grass, fail to produce any effect. The manure dries very quickly under the tropical sun and is trampled to bits and blown or washed away before it has time to produce any effect.

Although the sands of the Sahara are not immediately threatening the highlands of Kenya, another desert of a different type but equally greedy of fertile acres is already lapping round the base of the mountain ramparts which guard the green "heart of Africa". The thorn bush desert of Somaliland has already pushed its way southward across the Juba and Tana rivers; and its southern extremity is advancing into the once fertile valleys of Ukamba.

The question is sometimes asked "Are men, cattle and goats the sole destroyers, or is the advance of the desert mainly due to climatic change, geological disturbance or both?" There is reason to believe that the region lying north of the Kenya Highlands between Lake Rudolf and the Indian Ocean was, until comparatively recent times more fertile than it is to-day. The wells of Wajheir, the large reservoirs in Jubaland, now almost silted up and the ruins of ancient cities near the coast in areas where to-day no water can be found, all indicate that this region, not many centuries ago, supported a large and comparatively civilised population. Mount Marsabit is a volcanic range of recent origin, and it may be that its activity changed the face and climate of the surrounding country. But all this is conjecture. What we do know is that this desert, from whatsoever cause it originated, has advanced, is advancing and will advance still further wherever denudation and erosion provide an opening. Erosion in Kenya occurs in an aggravated form under the following conditions:—

1. Where the rainfall is definitely seasonal, *i.e.*, where there is a well-defined dry season of three months or more.

2. Where the annual rainfall is 30 inches or less.

3. Where the geological formation is schistose or a recent volcanic ash. The older lavas generally form a stiff compact soil on which erosion is less marked.

But whatever the conditions, erosion will occur sooner or later if over-stocking is permitted. In Kenya the situation has been aggravated during the last six years by a sub-normal rainfall and a heavy infestation of locusts. Now there are various remedies for erosion, which can be applied without delay and at no great expense. The natives of the Machakos district are both intelligent and industrious. Under the guidance of Government officials they have afforested considerable areas on the hillsides and have dug ditches and planted hedges along contour lines to stop "wash". All this is to the good. But they are averse to the application of the sovereign remedy, the drastic reduction of their livestock, which is necessary to provide scope for any large-scale scheme of soil-restoration. This aversion is hardly surprising. Livestock is the basis of their most cherished social institutions. It is their standard of value. There is no question of the gold standard in Ukamba. The tribe is only concerned with the maintenance of the goat standard, which has been their economic creed for untold generations. Without livestock a family can hardly maintain social respectability; and a suitor stands no chance of gaining the favour of the parents of his intended unless he can produce the customary cattle and goats.

In these circumstances it has not hitherto been considered advisable to enforce the ordinance providing for the compulsory culling of livestock. The difficulty of applying this law has hitherto been further enhanced by the inflated cash values which the natives place on their animals and by the impossibility of finding a market for many thousands of inferior cattle. The only possible method of disposing of them is through an extract and fertilizer factory. But whereas the native owner values a three-year old steer at about 20 shillings a factory could not at present prices pay more than six.

The position is a difficult one, but the problem must be faced. To enable the soil's natural cover of trees and herbage to re-establish itself, livestock must be excluded from the eroded areas. Where is it to go? It is probable that a survey of the thorn bush desert lying to the east of the district between the Tana and Athi rivers would reveal areas of grassland where large numbers of cattle would find sustenance if adequate water supplies were available. A solution of this problem may be found with the help of bore-holes and pipe-lines. Compulsory culling could then be gradually imposed in order to prevent over-crowding round the new water supplies. It is an expensive method; but when one reads that the President of the United States has decided to allocate two hundred millions to anti-erosion measures, one realizes that the task of restoring soil fertility is not likely to be a cheap one.

In the meantime the most suitable kind of vegetation for "holding the soil" in eroded areas suggests itself as an interesting subject for study and research.

THE GOLD COAST CACAO INDUSTRY.*

Cacao Prices in relation to Types grown.

THOUGH Gold Coast cacao accounts for nearly half the world's total production, its average price during the past five years has been only 63 per cent. of that of Trinidad cacao. Reference to other countries reveals even wider price differences according to the types of cacao grown. Of these, Criollo is the highest and Calabacillo the lowest, while there is an almost endless mixture of others to be found between these two extremes. Broad differences in type, also, distinguish producers. Thus, there are countries, like Trinidad, producing "fine" or "choice" cacao and others, like the Gold Coast, producing "ordinary" or "bulk" cacao. A remarkable change has taken place in the relation between "fine" and "ordinary" types during the past forty years. In 1895 "fine" types accounted for 78 per cent. of the total world exports, but by 1933 this percentage had shrunk to 13 per cent. Diminished production has, to a large extent, been responsible for maintaining the premia which "fine" cacaos enjoy over "ordinary" cacaos and there is little evidence to support the contention that there has been a significant narrowing of the margin between the two types. Nevertheless, manufacturers would welcome superior and better prepared Forastero cacao, while farmers would appreciate types giving higher yields of more valuable cacao. Gold Coast cacao, being based upon Amelonado, is of a poor type. Finer types exist, but it is doubtful whether their introduction on a large scale would lead to an appreciable improvement in quality or in price. Nor is it by any means certain that finer types would realise the existing premium if grown in enormous quantities because the present mixture of Forastero types has wider uses than Criollo in chocolate manufacture. There are probably 700,000,000 cacao trees in the Gold Coast and the introduction of an improved type would entail much effort and the lapse of a considerable period of time.

Methods of Preparation.

It is in respect of the methods of preparation that more immediate improvement can be effected. At present Gold Coast cacao is badly prepared because the farmer works on an average only four acres of cacao. This area is often sub-divided. The individual farm is too small to yield sufficient ripe pods to ensure proper fermentation of the wet cacao. Picking is delayed until the trees are laden with pods, all of which are removed with the exception of the very youngest. Reaping the major crop on many farms is completed in three rounds, and the intervals between pickings are frequently two or three months compared with three to five weeks in Trinidad. Every heap of pods examined contained a large percentage of unripe, over-ripe, germinated and diseased beans which even the most skilful planter could not transform into first grade cacao. Many defects in the quality of Gold Coast cacao can be attributed to the long interval between pickings, a factor which cannot be completely remedied by the individual effort of the farmer who must wait a long time if he is to obtain a large mass of wet cacao for fermentation. Also, the processes of picking, gathering, heaping, breaking and extracting are much less laborious for each unit when the quantity reaped is large than when it is small. The expenditure of great care and energy does not secure a commensurate premium. The individual Gold Coast farmer lacks both the ability and incentive to prepare cacao on plantation lines.

BREAKING OF PODS.

The methods in common use for breaking cacao pods are: (1) banging two pods together, (ii) striking the pod with a mallet, (iii) opening the pod longitudinally with a knife or cutlass, (iv) cutting the shell transversely with a knife or cutlass, and wrenching the pod in two with a quick turn of the wrist. The fourth method is by far the most efficient, and its superiority should be demonstrated by trained labourers. As a labour-saving method it should prove welcome.

FERMENTATION OF CACAO.

Cacao is usually fermented in :—

(i) *A Heap.*—A clean, level well-drained piece of ground is selected and covered with banana or plantain leaves on which wet cacao beans are piled in a conical mound and covered with more banana or plantain leaves. The heaps range in size from 1½ feet to 2½ feet in height and from 2½ feet in diameter. Drainage of the sweatings is sometimes defective, aeration often imperfect, and considerable differences in temperature exist between the centre, sides and bottom of the heap. "Slaty" beans also occur.

(ii) *A Hole.*—A basin-shaped hole about 2 to 2½ feet in depth and three to four feet in diameter is dug in the ground and lined with leaves. Wet cacao is placed within and the mass covered with leaves. Fermentation is slow and defective and aeration is imperfect. The use of the hole is dying out.

(iii) *A Container.*—The use of containers is becoming more common. A kerosene box, gin, case or small basket is lined, and the beans covered with leaves. Claims are made that the mass is more easily turned and mixed and that there is less danger of the beans entirely escaping the fermentation process.

* Compiled from excerpts of Professor C. Y. Shephard's Report published in the August, September, October, November 1935 issues of the *Gold Coast Farmer*. See also *Tropical Agriculture*, Vol. XII, No. 12, pp. 311-312.

The Department of Agriculture has recently advocated the use of a *three-tier fermentary* which consists of three boxes arranged at different levels. The wet cacao is placed in the highest box, transferred to the middle box after two days, and to the lowest box after another two days. By this method it is claimed that the beans are well mixed, and that good and even fermentation results. The size of box recommended is one foot long, one foot wide and 1½ feet deep which is sufficient to hold 2½ loads (150 lb.) of wet cacao at a time. A battery of three boxes could handle one ton of dry cacao in about 2½ months. This type of fermentary can be erected at little cost and is of a size suited to the Gold Coast farmer.

The small box or basket is well adapted to the small scale operations characteristic of the Gold Coast. Better results might be obtained by placing the box or basket in a larger container and packing the space between the two with leaves or old sacks. This rough insulation would help to conserve heat. The great drawback is that the quantity of wet cacao usually available is too small to ensure good fermentation. Provided, however, that an adequate quantity of suitable cacao is available, a farmer, using a simple but efficient fermentary and exercising reasonable care and attention during the curing process should be able to produce cacao fulfilling the requirements of manufacturers. The Gold Coast farmer has the advantage of a fairly uniform type of cacao. Trinidad cacao ranges from Criollo to Calabacillo, and while the former variety can be fully fermented in two days, the latter will not produce a good "break" even when fermented from 10 to 12 days. In spite of this difficulty, however, the Trinidad planter produces a better and more evenly fermented cacao than the Gold Coast farmer. Even the "ordinary" cacao produced by Trinidad peasant proprietors is better than that of the Gold Coast farmer. Moreover, small proprietors in Trinidad and Tobago who have combined together to ferment their ripe cacao, can produce a product equal in every respect to that of the large planter.

Turning and Mixing.

More attention should be paid to the simple process of turning and mixing the mass of wet cacao. Experiments indicate that turning and mixing the cacao twice during fermentation, say after two or four days, ensures better aeration, reduces mould and germination and results in more even fermentation. Yet this practice is often neglected by Gold Coast farmers although it is now becoming more common under the stimulus of the Department of Agriculture. Turning and mixing is one of the most important contributions which the individual farmer can make towards the improvement of Gold Coast cacao but the absence of price discrimination denies him an appropriate incentive.

Drying of Cacao.

The curing of cacao is completed by the process of drying, the usual method being to expose the cacao to the sun. In excessively humid climates (*e.g.*, the Cameroons) artificial dryers are used. In Togoland and the Eastern Province, cacao is sometimes dried over open fires, but the practice is rarely adopted elsewhere because it may give the cacao an objectionable "smoky" or "hammy" aroma. Manufacturers prefer sun-dried to artificially-dried cacao and there should be no difficulty in producing the former in the Gold Coast during the main season. Most farmers dry their cacao on mats of split palm-leaf stems or bamboo, which are usually raised two or three feet from the ground by a framework of sticks. Tarpaulins, concrete flooring, and trays (which can be pushed under a stationary galvanised iron or thatched roof), are also used. More recently the Gold Coast Department of Agriculture recommended a rough drying-shed with a light sliding roof, consisting of 100 sq. ft. of drying space, and capable of accommodating the equivalent of five loads (300 lb.) of cured cacao at a time. The shed can be constructed at a cost of £2 10s. The raised mat, however, would appear to be the drying equipment best suited to Gold Coast conditions. It is quite efficient if properly used. Its cost is small, repairs can easily be effected and the cacao can quickly be rolled up inside the mat during showers or taken in the house at night. Most of the other types of equipment are too large or costly.

A comparison of the Trinidad and Gold Coast methods of drying suggests that certain points omitted by the farmer may be partially responsible for the inferior quality of his cacao. In Trinidad the drying-floor is cleaned and allowed to dry. The fermented cacao is spread three or four inches deep, and during the first two days is turned at frequent intervals by a labourer who, with his feet, throws the beans into ridges, leaving "furrows" of exposed floor as he walks from end to end of the drying-floor. The exposed area is allowed to dry and the operation is repeated by breaking the old ridges and throwing up new ones on the dry portions of the floor. The cacao is subsequently raked into small heaps which are continually broken up and remade. Judicious use is made of the sliding roof which is run over the cacao when the sun is too hot or when it rains. The floor is kept as dry as possible. Towards the end of the drying process in Trinidad the beans are "danced" or polished by the feet of labourers. The principal and almost universal defect in the Gold Coast method of drying is the lack of attention given to the cacao after it has been spread on the drying tray (at an average depth of four to five inches). The beans are usually turned in the morning when the mat is spread, but are often exposed to the hot sun during the rest of the day without being "worked". The beans on the surface collapse, and assume a wrinkled and concave appearance while those in the lower layers remain

damp, lose heat and become mouldy. The practice of rolling up the mat at night helps to conserve heat but the mat itself is seldom cleaned.

No farmer appears to have adopted the Trinidad method although there is little doubt that a suitable modification of it would greatly improve the quality and appearance of Gold Coast cacao, particularly if the principal defects which include mould, germinated beans, slate, weevil and other inferior and foreign material were removed. No marked improvement in the preparation of cacao is likely to occur, however, until price discrimination is introduced. At present no premium is received by farmers who take great care in the preparation of their cacao because improved lots of cacao are too small to be recognised by merchants who handle thousands of tons. The solution lies in the formation of co-operative fermentaries which can handle every operation of preparation on a larger scale, and thereby produce a cacao of marked superiority.

G. G. G.

TUNG OIL*:

Aleurites: A Crop with a Future.

SINCE the war tung oil, from the seeds of *Aleurites Fordii*, has become an indispensable raw material of the paint and varnish trade throughout the world. Its high consumption by the aviation and electrical engineering trades and the great number of uses which are being found for it in other modern developments of industry have all tended to promote a marked interest in establishing the tung oil tree in countries other than China, which for years has held the monopoly of the tung oil trade. The oil exported from China consists of about 90 per cent. of the oil of *Aleurites Fordii* (true tung oil) mixed with that of *Aleurites montana*; its composition and quality varies and it is often adulterated with cheaper vegetable oils; even so it may be ranked with linseed oil as one of the staple raw materials of commerce for which there will always be a steady demand. It is considered also that the oil will always command at least £10 per ton above that of linseed oil. Moreover, an acre of suitable land will produce up to 1,200 lb. of tung oil, as against 250 to 300 of linseed and groundnut oils.

An attempt to establish the tung oil tree on a commercial basis in U.S.A. was made in Florida as far back as 1905. Climatic conditions in Florida are similar to those of the Chinese tung oil districts, and the success of the enterprise is shown by the gradual extension of the plantations to the neighbouring states, the total acreage amounting to over 29,000 acres in 1934, and with it the possibility of producing tung oil on a commercial scale.

American experience has given a good deal of impetus to the introduction of tung trees in the Empire, and although many of the experimental plantings were not begun until 1927, there is already some evidence that success may be expected. In some countries, notably India, Australia and New Zealand, interest in tung oil is reflected in the number of private companies which have begun work on estate lines. In the Northern Shan States, India, Tung Oil Estates Ltd. have about 1,470 acres under *Aleurites Fordii* and *A. montana*; in 1932 Tung Oil (Australia) Ltd. prepared to establish a 1,000 acre plantation near Sydney, whilst other plantations have been established in Queensland; in New Zealand five public companies with a total nominal capital of £780,000 have been formed to develop tung oil estates in North Auckland. Three of these companies were arranging to plant a total of 1,500 acres in 1932. Extremely promising results with *A. Fordii* are also being obtained in the Ranchi District of Chota Nagpur, Bihar and Orissa.

In South Africa tung oil appears to do well in the coastal belt of Natal and Zululand, in parts of Swaziland and in the north-east of Transvaal. The number of trees under cultivation is estimated at over 20,000 with about 2,000 seedlings ready for planting out, though this is a very conservative estimate. In Kenya, *A. Fordii* has proved disappointing but the *montana* species promises well. In Nyasaland the acreage under tung has increased from 65 in 1933 to 184 in 1934; both species appear to do well and yield oil of satisfactory quality.

Many of the reports from the Empire show the significance of the insistence of American workers on careful nursery management, and lack of attention to this would appear to be the cause of many avoidable failures. In some countries, as in Kenya, the lack of a cold resting period during the winter is a drawback to success at least with *A. Fordii*; in others early frost damage, which is particularly harmful to nursery stock, is a problem which may resolve itself into one of altitude.

A. montana appears to withstand heavier rainfall and to require higher temperatures than *A. Fordii* from which the true tung oil is derived. In connection with the success or failure of the two *Aleurites* species in the Empire one has to consider the relative commercial value of the oil they produce. It is not yet definitely established that the oil of *A. montana* possesses equal powers of gelation or is equal in value to *A. Fordii* oil, indeed there is some evidence that the *montana* oil is somewhat inferior and takes longer to polymerise. It is worth noting that practically all the commercial firms operating in America and in the Empire are growing *A. Fordii* rather than *A. montana*. This question of the variety is perhaps one of the most important affecting the regional development of tung oil production in the Empire. The demand for tung oil is at present greater than the supply, and in such times the conditions are particularly favourable for gaining experience.

* *Monthly Letter*, No. 50, 1935, issued by the Imperial Bureau of Soil Science.

PROGRESS REPORT ON THE INTRODUCTION OF A PARASITE OF THE CACAO THRIPS FROM THE GOLD COAST TO TRINIDAD, B.W.I.

By A. M. Adamson,
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Introduction.

Within the last twenty years the Cacao Thrips (*Selenothrips rubrocinctus* Giard) has been a very serious pest in Trinidad, where it has been studied chiefly by Urich (1 and 2). The writer began investigations in 1933 by making an examination of its status. It was apparent that the thrips were so widespread that few estates escaped damage, and that losses of half and even more of the crop were occurring in some areas. Attacks seemed to be increasing in extent and severity. Control with Bordeaux Mixture had proved effective (2 and 4), but owing to the high cost of spraying and to low profits was not in general use. It was therefore recommended, in a report submitted to the Director of Agriculture in Trinidad in 1934, that the introduction of the parasite, *Dasyscapus parvipennis* Gahan, already advocated by Myers (3), be immediately attempted. In London in 1934 the writer had the opportunity of discussing the matter with Mr. G. S. Cotterell, Entomologist in the Department of Agriculture, Gold Coast, and in the summer of 1935 the Director of Agriculture in Trinidad was successful in making arrangements whereby Mr. Cotterell undertook the shipment of parasites. This was accomplished during August to November, 1935. The first two shipments, on their arrival in Trinidad, were placed in charge of Professor F. W. Urich. On return from leave in September the writer was asked to take over the work, Professor Urich being occupied with research on other problems.

The progress that has so far to be recorded in the introduction of this parasite is due to the efforts of several workers. Acknowledgment should be made in the first place to Mr. E. J. Wortley, Director of Agriculture, Trinidad and Tobago, for his initiative in making the necessary arrangements between the governments of this Colony and of the Gold Coast, and to Mr. Cotterell for his success in shipping live parasites over the long journey from Africa to Trinidad. To Professor Urich is due the credit of rearing the first generation of parasites in Trinidad. Mr. Alan Pickles, Entomologist of the Trinidad Department of Agriculture, has co-operated in all phases of the project. Most of the work of breeding parasites in the laboratory has been done by Miss Patricia Atteck, Technical Assistant in Entomology at the Imperial College.

The Parasite.

Dasyscapus parvipennis is a member of the family Eulophidae, in the large group of Chalcid wasps, which includes many parasites beneficial to man. It was described as a new genus and species in 1928 by Gahan (5), from specimens reared from the Onion Thrips (*Thrips tabaci* Lind.) in Java, where it was first reported, without name, by Van Heurn (6) in 1923. In 1931 Ferrière (7) recorded it from the Gold Coast, where Cotterell (8 and 9) found it parasitising and apparently controlling the Cacao Thrips.

The adult parasite is a minute wasp about 0.6 mm. long. The head and thorax are black, the antennae (feelers), legs, and abdomen pale yellow. In the male the first joint of the antenna is so greatly swollen that it is easy to distinguish the sexes without magnification. The female lays a single egg inside the body of an immature thrips, which dies, usually before pupating, after about seven days. The parasite larva is then visible through the empty skin of its host, and pupates about two days later. The wasp pupa, which is entirely black, adheres by the cast-off skin of the thrips to the surface of the leaf or other object on which its host has died. The pupal stage lasts about ten days, the entire life-cycle about 20 days.

In Trinidad up to 70 offspring have been obtained from a single female. Females excluded from males have produced only male progeny. In addition to the two previously recorded hosts—the Onion and Cacao Thrips—two other species of thrips, as yet tentatively identified, have been parasitised by *Dasyscapus* in the laboratory.

Shipment of Parasites.

The parasites were shipped by Mr. Cotterell by steamer from Accra, Gold Coast, to Bathurst, Gambia; by German air-mail from Bathurst to Natal, Brazil; and by Pan-American Airways from Natal to Trinidad. The first shipment, received in Trinidad on August 27, after a journey of 19 days owing to missed connection at Bathurst, yielded one live male; the second, received on 17th September, after only nine days, 188 adults of which about ten per cent. were males; the third, received on 15th October, after 17 days, no live parasites; and the fourth, received on 8th December, after 14 days, ten males and 50 females. Cool storage, at about 50°F., was used during part of the journey for part of the second shipment and for all of the fourth.

Both parasitised thrips and wasp pupae were shipped. The pieces of leaf to which they had adhered were pinned to strips of cork in tubes of metal or wood. A raisin fixed to the cork provided food and moisture for parasites emerging *en route*. None of the thrips reached Trinidad alive, and no hyperparasite of *Dasyscapus* was found.

Breeding in the Laboratory.

From the 188 live parasites received in Trinidad on 18th September, 1935, seven generations have been bred in the laboratory, numbering respectively 90, 80, 500, 2,300, 10,000, 10,000 and 12,000. Several methods of rearing parasites have been employed, including the use of cages over small potted cacao plants and over branches of cashew trees in the field. The following procedure has been generally adopted, as the most satisfactory yet found here.

Adult wasps are allowed to emerge from their pupae in glass cylinders, nine inches long and five inches in diameter, closed at both ends by muslin held by rubber bands. Food is provided by a raisin, and by a 20 per cent. sugar solution on blotting paper, and water by moistening the muslin. After a few hours, during which the wasps have been mating actively, young thrips are introduced, on heavily infested leaves collected in the field. About 200 thrips are allowed to each female wasp. Cashew leaves have been generally used because they wither less quickly than cacao leaves, and because very large numbers of thrips have been found on cashew trees in the neighbourhood of the laboratory.

After about one day's exposure to the parasites, the thrips and the leaves on which they are feeding are transferred to battery jars of 12 by 9 by 7 ins. A humid atmosphere is maintained by means of damp blotting paper at the top and bottom of the jar and a glass cover at the top, and in it leaves remain sufficiently fresh for the thrips to feed upon for a few days. New leaves are added when necessary, and the thrips quickly move to them.

A further supply of thrips is added to the glass cylinders in which the wasps have been left. This is repeated daily as long as live parasites remain.

After pupation of the parasites, the leaves to which they are attached are removed to jars covered with muslin. Some of the pupae are detached from the leaves with a moist paint-brush and placed on cards, for convenient handling in the laboratory.

Liberations.

About 26,000 parasites have so far been liberated, as follows :

Mausica Savannah, cashew plantation, 13th Nov., 1935	35
Las Hermanas, San Rafael, cacao plantation 15th Nov.	50
Santa Maria, Montserrat, cacao, 2nd Dec..	1,000
Mausica Savannah, cashew, 4th Dec. ..	520
Near Sangre Grande, cacao, 21st Dec. ..	730
Las Hermanas, cacao, 22nd to 24th Dec. ..	6,000
St. Augustine, cashew, 2nd to 4th Jan., 1936	700
Mamoral, Montserrat, cacao, 11th Jan. ..	3,000
Montevideo, Toco, cacao, 12th Jan. ..	1,500
El Reposo, Montserrat, cashew, 13th Jan. ..	1,800
La Luisa, Montserrat, cacao, 13th Jan. ..	1,000
River Estate, Diego Martin, cacao	500
Montevideo, Toco, cacao, 2nd and 5th Feb. ..	9,000
Bellevue, Penal, cacao, 5th Feb.	500

Most of the parasites have been liberated as pupae, the leaves to which they are attached being placed in tins protected from ants and spiders. Subsequent examination has shown that adults have emerged from over 90 per cent. of the pupae. In some cases, especially with small numbers, the wasps have been allowed to emerge before liberation, in order to facilitate mating.

Recoveries.

At most of the points of liberation small numbers—not exceeding 100 in one locality—of parasitised thrips and wasp pupae have been recovered within two or three weeks—in one place after six weeks—of the time of liberation. Such recoveries are as yet of little significance, because of the short interval of time, and because, in most places, the thrips population had diminished between the times of liberation and recovery.

The breeding and liberation of parasites are being continued. The prospects for their establishment in Trinidad appear to be good, though the ultimate results as regards control of the thrips may of course remain unpredictable for some years. Since *Dasyscapus* has already been recorded as a parasite of two serious and widely distributed pests, the Cacao and Onion Thrips, and since it has been found to parasitise both of the additional hosts thus far offered to it in Trinidad, it may prove to be of use for biological control in many countries.

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RECENT INVESTIGATIONS ON SUGAR-CANE AND SUGAR-CANE SOILS IN ST. KITTS.

I.—PRELIMINARY RESULTS OF THE NEW EXPERIMENTAL SCHEME.

By P. E. Turner, R. E. Kelsick and G. B. Gregory.

Introduction.

There are recorded in this paper a preliminary series of results obtained from a scheme of field experiments inaugurated in 1933 under the auspices of the Sugar-Cane Investigation Committee of St. Kitts. The scheme is a consequence of a critical review of agricultural practices in use on sugar estates in St. Kitts, which has been published elsewhere (1). Results obtained from a similar scheme of experiments in Antigua have previously been described in this *Journal* (3).

Previous Field Experiments.

Manurial experiments were commenced in St. Kitts in 1899, at the time of the creation of the Imperial Department of Agriculture for the West Indies, and were continued until 1918. They were resumed in 1921. The main conclusions to which the earlier experiments gave rise have been summarised by Tempany (4). Kelsick (5) has reviewed the results of the more recent experiments in relation to general manurial policy in St. Kitts. It has been shown by Kelsick that in a year of extreme drought only a very small gain in yield of plant canes results from a heavy dressing of pen manure; that in a more normal year pen manure can be advantageously supplemented with sulphate of ammonia on the wet areas; that if it is found possible satisfactorily to replace pen manure by inorganic manure it is unlikely that use of sulphate of ammonia alone will suffice; and that the optimum dressing of sulphate of ammonia to ratoon canes may lie in the region of three to four cwts. to the acre.

Variety trials have been carried out in St. Kitts since 1900. The situation with regard to varieties has been discussed by McIntosh (6), who considers that B.H. 10(12) is well suited to the wet areas of the island, but that there is need to replace S.C. 12/4 on the dry areas by a variety which will not lose weight during the crop season and which will ratoon more satisfactorily.

The results of experiments laid down in 1908 and 1933 leave doubt as to whether it pays to cultivate ratoon canes.

The New Scheme of Experiments.

The new scheme of experiments is designed in the course of time to make thorough and systematic inquiry into the more fundamental practices in standard use on the sugar-cane areas of St. Kitts, and to compare their merits with alternative practices which have proved successful in Trinidad and elsewhere, due regard being paid to the special conditions which obtain.

Detailed descriptions of the new experimental scheme have previously been published (1). As the scheme develops it is intended to include experiments grouped under the following headings:—

- Variety Trials.
- Preparation of the Soil for Planting.
- Use of Lime on Acid Soils.
- Method and Time of Planting.
- Cultural Treatment after Planting.
- Manurial Treatment of Penmanured and Unpenmanured Soils.
- Conservation of Soil Moisture in the Dry Areas.
- Cultural Treatment of Ratoon Canes.
- Manurial Treatment of Ratoon Canes.

The distribution throughout the island of the 1933-35 and 1934-36 series of experiments on plant canes and the 1934-35 and 1935-36 series on ratoon canes is illustrated on the accompanying map. The results outlined in this paper were obtained from the 1933-35 experiments on plant canes and the 1934-35 experiments on ratoons.

The Physical Features and Soils of St. Kitts.

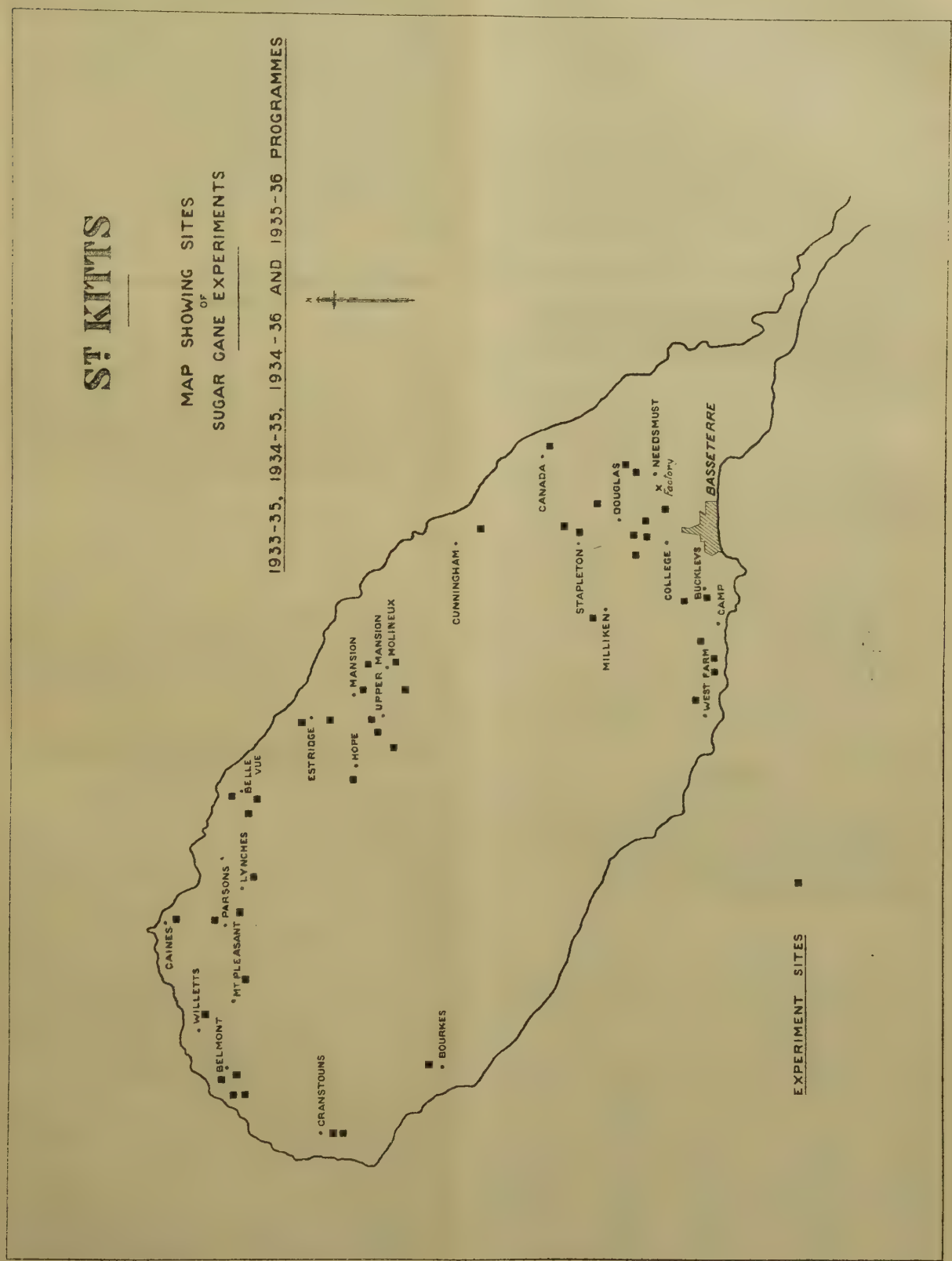
The island of St. Kitts is mountainous, its axial part consisting of a lofty range which rises to 3,700 feet. Everywhere from 1,100 feet to the sea level is a gently sloping glacis of detrital volcanic material. On this glacis, which at the lower levels is traversed by deep ravines, sugar cane is grown. Above 1,000 feet the mountains are covered by virgin forest.

The soils of St. Kitts are light, sandy loams, except in the north-western section of the island where fine silt predominates over sand. They are open and porous in texture and low in organic matter. They dry out rapidly. They are extremely easy to work and can be tilled shortly after heavy rain without harm. No system of field drains is necessary.

On account of their sandy nature the soils lend themselves to erosion. During heavy rainfall the finer particles of the upper lands are transported to the lower levels, and in the course of time to the sea.

An average value for mechanical analyses of soil samples taken from 32 localities (5) within the sugar areas, with the maximum and minimum recorded values, is set out below.

Component.	Average value.	Maximum value.	Minimum value.
Gravel ..	22.5	41.4	9.7
Sand ..	44.4	62.5	30.2
Silt ..	26.4	51.6	13.8
Clay ..	2.3	7.0	0.3


ST. KITTS
MAP SHOWING SITES
OF
SUGAR CANE EXPERIMENTS
1933-35, 1934-35, 1934-36 AND 1935-36 PROGRAMMES
N
CAINES
WILLETTS
BELMONT
PARSONS
MT. PLEASANT
LYNCHES
BELLE VUE
CRANSTOUNS
ESTRIDGE
HOPE
MANSION
UPPER MANSION
MOLINEUX
BOURKES
CUNNINGHAM
CANADA
STAPLETON
MILLIKEN
DOUGLAS
NEEDSMUST
X Factory
COLLEGE
BUCKLEYS
BASSETERRE
CAMP
WEST FARM
EXPERIMENT SITES

Classification of the Sugar Areas.

The sugar growing regions of St. Kitts may be classified into well-defined groups dependent on their position on the glacis (which in turn has for years determined the general nature of their manurial treatment) and on the rainfall.

(1) *Lower Lands*, which form the coastal belt at the foot of the glacis.

The soils of the lower lands in general are fertile and deep. They are customarily pen-manured at each replanting, as the lie of the land enables this manure to be transported to the field without difficulty. They are neutral or slightly alkaline in reaction.

Two rainfall zones may be distinguished within the lower lands :—

(*a*) a zone of low rainfall, where lack of moisture is the main factor limiting yields, and to which the variety B.H. 10(12) is not suited ;

(*b*) a zone of good rainfall as a rule, to which B.H. 10(12) is well suited, but which on occasion is subject to severe drought.

(2) *Upper Lands*, which are bordered on the lower side by the coastal belt and on the upper side by virgin forest.

The soils of the upper lands are variable in depth and in some areas have suffered severely from erosion. The gradients and long haulages make impossible transport of pen manure to the field. The soils are less fertile on the average than those of the lower lands, and tend to be acidic in reaction.

In general, rainfall is not only ample but well distributed on the upper lands, and B.H. 10(12) is the variety preponderantly grown. Rainfall may however be a limiting factor in certain isolated areas.

Rainfall.

Average rainfall figures in inches (5) are reproduced below for sugar estates situated on the dry and wet areas of the lower and upper lands. The results of experiments laid down on these estates are described in this paper.

Month	Lower lands (1919-34).		Upper lands (1914-34).	
	Dry area (Buckleys)	Wet area (Molineux)	Dry area (Bourkes)	Wet area (Parsons)
Jan.	3.53	3.60	3.72	3.49
Feb.	1.95	2.51	2.26	2.77
Mar.	2.69	3.44	2.95	2.98
April	2.96	5.37	3.66	5.88
May	2.86	4.34	3.83	5.61
June	3.41	4.56	3.97	5.01
July	4.74	5.34	5.44	5.86
Aug.	5.23	5.90	4.93	4.66
Sept.	6.86	7.89	6.30	6.46
Oct.	4.93	6.80	5.78	6.64
Nov.	6.23	7.92	6.73	10.62
Dec.	4.45	4.79	4.73	4.64
Total	49.84	62.46	54.24	64.62

Due account should be taken of the lightness of texture and the high degree of porosity of the soils of St. Kitts when consideration is given to the rainfall data. Under the conditions which obtain, the slightly greater precipitation which occurs on the wet areas than on the dry areas of the lower and upper lands during the latter half of the dry season (*i.e.*, during April, May and June), and on the wet areas than on the dry areas of the lower lands during October, can make a very great difference to yield of cane.

The rainfall for Parsons Estate is lower than that which obtains on the average for the upper lands.

Yield Data from the Preliminary Set of Experiments.

Many of the experiments were laid down late in the planting season (1). In consequence maximum benefit could not be derived from the cultural and manurial operations under test. The late start also made it difficult in certain cases to find suitable unmanured or unplanted experimental sites, and it was frequently found necessary to make the best of unsatisfactory conditions.

Variety Trials on Plant Canes.

The varieties recorded in Tables I, II and III were compared at the suggestion of McIntosh.

The Dry Areas of the Lower Lands.

The variety S.C. 12/4 is largely grown in the dry areas. Data are recorded in Table I which enable a comparison of the yield of cane and sugar given by this variety and the new Barbados seedling B. 2935.

Table I.—A comparison of the standard variety S.C. 12/4 with B. 2935.

Estate : Camp. *Soil :* Sandy loam.
Planted : 7/11/33. *Reaped :* 12/2/35.
Total rainfall (15¼ months) ; 66 inches.
Layout : Six randomised blocks with both varieties repeated twice in each block.

Variety.	Yield (tons per acre).		Sucrose in juice.	Purity of juice.
	Cane.	Sugar.	lbs. per gallon.	
B. 2935 ..	47.38	4.44	1.599	85.9
S.C. 12/4 ..	36.06	3.47	1.774	88.9
Difference	+11.32	+0.97	−0.175	−3.0

Rainfall on the experimental area during the dry season of 1934 was as follows :—

February	....	....	0.52 inches.
March	....	....	4.26 do.
April	....	....	0.23 do.
May	....	....	1.16 do.
June	....	....	1.13 do.

The month of October also was dry, with only 1.36 inches of rain.

The experiment was reaped early in the dry season. At the time of reaping no rotted cane was found in either series of plots.

The variety B. 2935 *gave* 11.32 *more tons of cane to the acre than S.C.* 12/4. *The variety S.C.* 12/4 *was definitely the riper at the time of harvesting, nevertheless it gave one ton less sugar to the acre than B.* 2935. The differences in yield of cane and of sugar in favour of B. 2935 might be due to chance far less than once in 100 times.

On the experimental area the habit of B. 2935 was somewhat recumbent and the canes tended to root freely at points at which the nodes made contact with the soil. Further there appeared to be a general tendency towards pithiness in the stems. These factors, which probably contributed to the poorer juice quality of B. 2935, were not noticeable in the variety trial at College Estate (Table II).

The results of a trial which includes the varieties S.C. 12/4, B. 2935, B. 726, P.O.J. 2878 and G. 119 are set out in Table II. The yield data are of particular interest in that they afford a comparison of the merits of these varieties when reaped both early and late in the dry season. Each value recorded in the table is a mean for ten replicates.

Table II.—A comparison of varieties under conditions of early and late reaping.

Estate : College. *Soil :* Sandy loam.
Planted : 26/11/33.
Reaped : 21/2/35 (early), 11/5/35 (late).
Rainfall : 59 inches (14¾ months), 66 inches (17½ months).
Layout : Four 5 × 5 Latin squares.

Variety.	Yield of cane (t.p.a.)		Yield of sugar (t.p.a.)		Average values.	
	Early reaping.	Late reaping.	Early reaping.	Late reaping.	Cane.	Sugar.
P.O.J. 2878	37.26	39.00	3.75	4.12	38.13	3.93
B. 2935	39.63	33.30	4.25	3.62	36.46	3.93
B. 726	33.39	30.01	3.68	3.57	31.70	3.62
S.C. 12/4	31.71	29.66	3.19	3.13	30.68	3.16
G. 119	36.20	26.23	3.37	2.63	31.21	3.00

The germination of B. 2935 was poor, and difficulty was experienced in obtaining a satisfactory stand of this variety.

The rainfall on the experimental area during the dry months of 1934 was :—

February	....	....	0.65 inches.
March	....	....	3.70 do.
April	....	....	0.05 do.
May	....	....	1.10 do.
June	....	....	1.65 do.
October	....	....	1.90 do.

The monthly rainfall covering the period between the early and late harvestings in 1935 was :—

February	....	....	2.50 inches.
March	....	....	1.25 do.
April	....	....	1.45 do.

Yield of Cane.

For the early reaping a difference in yield must exceed 2.48 tons to the acre to be statistically significant. *The variety B.* 2935 *gave a larger yield of cane than B.* 726, *S.C.* 12/4 *and G.* 119. The variety P.O.J. 2878 gave a larger yield than B. 726 and S.C. 12/4.

For the late reaping a difference must exceed 2.97 tons to be due to chance less than once in 20 times and 4.01 tons to be due to chance less than once in 100 times. The variety P.O.J. 2878 gave a larger yield than all other varieties. The variety B. 2935 gave a larger yield than B. 726, S.C. 12/4 and G. 119. The variety G. 119 gave a smaller yield than all other varieties.

Of the five varieties, P.O.J. 2878 *alone continued to increase in yield throughout the dry period between the two times of reaping.* The varieties B. 2935 and G. 119 suffered the most seriously during the interval, losing to the acre six and ten tons in weight, respectively.

On the average, (*i.e.* for the early and late reapings) there is little to choose between the yield of cane given by the varieties P.O.J. 2878 and B. 2935 at the head of the list. Equally poor average yields were given by the varieties B. 726, S.C. 12/4 and G. 119.

The variety P.O.J. 2878 gave the largest yield of plant canes to the acre in an experiment on a dry area reaped early in the crop season of 1933 (5). The trial did not include B. 2935.

Yield of Sugar.

For the early reaping a difference exceeding 0.12 tons of sugar to the acre might be due to chance less than once in 100 times. The variety B. 2935 gave the largest yield. P.O.J. 2878 and B. 726 come next in order. S.C. 12/4, at present the most largely grown in the dry areas of the five varieties under trial, lies at the bottom of the list. *As in the experiment at Camp Estate (Table I), S.C.* 12/4 *gave one ton of sugar to the acre less than B.* 2935.

For the late reaping a difference of 0.43 tons of sugar to the acre is necessary for statistical significance. Delay in reaping the variety P.O.J. 2878, until towards the end of the dry season, led to an increase in yield of sugar. The delay had little effect on the yield given by the varieties B. 726 and S.C. 12/4. It caused a loss in yield in excess of 0.6 tons of sugar with the varieties B. 2935 and G. 119.

On the average (*i.e.* for the early and late reapings) there is nothing to choose between the varieties P.O.J. 2878 and B. 2935. The varieties S.C. 12/4 and G. 119 gave the lowest yields of sugar. B. 726 takes an intermediate place.

The variety B. 726 gave the juice of highest purity in both the early and late reapings. Purity values for the varieties have been published elsewhere (5).

THE WET AREAS OF THE LOWER LANDS.

B.H. 10(12) is the predominant variety in the wet areas. P.O.J. 2878 and B. 374 are grown to a limited extent. Data are recorded in Table III, which enable a comparison of yields given by these varieties, and by the recent Barbados seedling B. 726, at two different sites.

Table III.—A comparison of varieties under conditions of adequate rainfall.

Estate :	Molineux.	Belmont.
Soil :	Sandy loam.	Silty loam.
Planted :	2/11/33.	14/11/33.
Reaped :	26/2/35.	2/4/35.
Rainfall :	(16 months) 88 inches.	(16½ months) 102 inches.

Layout : Two 4 × 4 Latin squares at each site.

Variety.	Yield of cane (t.p.a.)		Yield of sugar (t.p.a.)		Average values.	
	Molineux.	Belmont.	Molineux.	Belmont.	Cane.	Sugar.
B.H. 10(12)	44.68	50.00	4.71	5.42	47.34	5.06
B. 726	40.33	47.21	4.64	5.51	43.77	5.07
B. 374	46.25	45.30	4.51	4.71	45.77	4.61
P.O.J. 2878	44.28	36.18	4.60	3.77	40.23	4.18

The rainfall on the two estates during the dry season of 1934 was :—

Month.	*Molineux Estate.*	*Belmont Estate.*
February	2.02 inches	2.48 inches
March	6.47 do.	8.08 do.
April	1.51 do.	1.34 do.
May	4.66 do.	2.20 do.
June	2.68 do.	2.31 do.

The experiments were planted during the first half of November. The experiment at Molineux Estate was reaped late in February, 1935; that at Belmont Estate was reaped early in April, 1935.

Yield of Cane.

At Molineux Estate a difference between any two mean yields of cane must exceed 3.95 tons for statistical significance. There is therefore nothing to choose between the yields given by the varieties B.H. 10(12), B. 374 and P.O.J. 2878. Each of these varieties gave a significantly larger yield than B. 726, but measurements made ten weeks after planting showed the germination of B.726 to be less satisfactory than that of the other varieties.

At Belmont Estate a difference in yield exceeding 3.41 tons of cane is necessary for statistical significance. The difference in yield between B.H. 10(12) and B. 726 may therefore be due to chance factors such as soil variation. In this experiment the germination of B. 726 was as good as that of B.H. 10(12). The yield of B. 374 is significantly smaller than that of B.H. 10(12), but the former variety did not germinate well. The yield of P.O.J. 2878 is considerably smaller than that of the other three varieties. The germination and early growth of P.O.J. 2878 were excellent, but roughly 60 per cent. of the stools were uprooted by high winds, and at the time of reaping there was an average of 200 dead canes to the plot (6,000 to the acre). Collapse of the stools of P.O.J. 2878 through this cause is by no means uncommon in St. Kitts.

As far as yield of cane is concerned, on the average for the two experiments, B.H. 10(12) *takes first place and is closely followed by B.* 374.

Yield of Sugar.

At Molineux Estate the differences in yield of sugar to the acre cannot definitely be ascribed as varietal and may be due to chance factors. When account is taken of juice quality the variety B. 726 rises from bottom place in the list to a position of equality with B.H. 10(12).

At Belmont Estate differences exceeding 0.56 tons of sugar to the acre might be due to chance less than once in 100 times. *The yields of sugar to the acre given by B.H.* 10(12) *and B.* 726 *may therefore be taken with certainty to be larger than those given by B.* 374 *and P.O.J.* 2878. *A similar conclusion may be drawn for the average yields of sugar for both experiments.*

The variety P.O.J. 2878 gave the largest yields of plant cane and sugar to the acre in a similar trial which was reaped early in the dry season of 1933 at Molineux Estate (5).

General Comments on the Varieties under Comparison.

The following comments summarise the general views of McIntosh on the varieties under comparison:

B. 2935.—It is probable that further tests will show B. 2935 to be the variety most suited to the major portion of the dry areas of the lower lands.

S.C. 12/4.—As far as the plant-cane crop is concerned this variety may be regarded almost with certainty as inferior to B. 2935 under the conditions of lower rainfall.

G. 119.—Susceptibility to rotting, and poor quality of juice, definitely lead to the conclusion that G. 119 is an undesirable variety.

P.O.J. 2878.—The erratic results given by P.O.J. 2878 in the West Indies strongly suggest that it is unsuited to St. Kitts as a commercial variety, especially in view of the consistent results of high standard given by existing West Indian varieties.

B. 726.—This variety may give satisfactory results in the wetter districts of the dry areas. In the wet areas it is worthy of further trial as a variety for reaping early in the dry season.

B. 374.—Poor factory qualities and susceptibility to rotting leave no doubt that this variety is inferior to B.H. 10 (12).

B.H. 10(12).—At present B.H. 10(12) is by far the most satisfactory variety for the wet areas.

Methods of Preparatory Cultivation.

CLOSE PLOUGHING *v.* STANDARD METHOD.

In St. Kitts ploughing is performed with cattle. Before planting only the strips of soil between the lines of stubble are tilled. Two or three cuts are made with the plough in these strips and the furrow slice is turned on the old line of stools. In due course, after planting, the unworked strips between the young plant canes are 'subsoiled' with a chisel or similar implement.

The question arose as to whether maximum results are obtained by the present procedure and as to whether it would pay to till the full area of soil before planting (1). Preliminary experiments were therefore laid down on the dry and wet areas of the lower lands to compare the merits of close ploughing by cattle with the standard practice. Yield data from these experiments are recorded in Table IV.

Table IV.—Close ploughing v. standard practise in relation to yield.

Area :	Dry.	Wet.
Estate :	Needsmust.	Molineux.
Variety :	B.H. 10 (12).	B.H. 10 (12).
Planted :	2/12/33.	25/2/34.
Reaped :	5/3/35.	23/5/35.
Rainfall :	(15½ months) 65 inches.	(15 months) 62 inches.

Layout : Randomised blocks, with both treatments repeated twice in each block.

Type of ploughing.	YIELD OF CANE (tons per acre).	
	Dry area*.	Wet area.†
Standard ..	18.10	38.14
Close	17.16	37.64

* Mean yields for 12 replicates.

† Mean yields for 16 replicates.

In neither experiment did close ploughing before planting lead to an increase in yield. On the deeper soils of the lower lands it would appear that the strips of soil between the stubble provide adequate room for root development during the early stages of life of the plant. This type of experiment is worthy of repetition on the more shallow soils such as occur in the upper lands.

The two preliminary experiments on close ploughing have made it evident that uprooting old cane stumps can put a very heavy strain on cattle even on light volcanic soils and that mechanical traction will probably be essential if it should become worth while to practise close ploughing on an extensive scale in St. Kitts.

Optimum Use of Lime.

IMMEDIATE EFFECT OF SLAKED LIME ON YIELD.

Liming is an expensive operation, as a rule. It differs from manuring with inorganic manures in that the gain in yield which results is not confined to a single crop, but may be spread over a long succession of crops (7). In consequence it is a matter of importance to determine the size of dressing which can most advantageously be applied to acid soils.

On the clay soils of Trinidad it has been shown by field experiments that maximum financial gain results from a dressing of lime at each reploughing equal to half the lime requirement of the soil. Similar experiments have been laid down on the wet areas of the upper lands of St. Kitts to obtain a measure of the optimum dressing of lime on light volcanic soils. In these experiments the effect on yield of applications equal to half the lime requirement, the lime requirement, and one-and-a-half times the lime requirement are under investigation. The effect of these dressings on the yield of the first crop of cane reaped on one experimental area is recorded in Table V. Slaked lime, burnt locally, was used in this trial.

Table V.—Immediate effect of slaked lime on yield of plant canes.

Estate : Mansion. *Variety :* B.H. 10(12).
Limed : 21/11/33.
Planted : 23/1/34. *Reaped :* 5/6/35.
Rainfall (16½ months) : 69 inches.
Layout : Two 4 × 4 Latin squares.

L.R.=calculated lime requirement of the soil.

Dressing of slaked lime.	Yield of plant canes. (tons per acre)	Immediate gain.
Nil	38.19	—
½ L.R. (1.55 tons) ..	40.66	2.47
L.R. (3.10 tons) ..	42.03	3.84
1½ L.R. (4.65 tons) ..	43.75	5.56

These data give an idea of the size of the immediate gain in yield which can result from dressings of locally prepared lime under the conditions which in general obtain on the upper lands of St. Kitts. The gain in yield of plant canes due to liming might be due to chance less than once in 100 times. Yield increases in accordance with the law of diminishing returns as the dressing of lime increases, *i.e.*, the gain due to the half dressing is proportionately greater than the gain due to the full dressing, which in turn is proportionately greater than that due to the maximum dressing. The experiment is to be continued to obtain a measure of the residual effects of the various dressings on subsequent crops.

In a similar experiment laid down at Parsons Estate dressings of slaked lime, locally burnt, gave rise to no gain in yield of plant canes.

The lime used in the experiments at Mansion and Parsons Estates was poor in quality and contained considerable quantities of unburnt stone. Loose lumps of lime were still evident on the surface of the plots at the time of reaping. It has been found in Trinidad that paying gains result from liming only by the use of finely divided material which can be intimately mixed with the soil (7).

Methods of Planting.

EFFECT OF SPACING DISTANCE ON YIELD OF CANE.

Optimum distance of planting is dependent on many factors which have been discussed elsewhere (2). It can be determined only by a carefully devised series of experiments continued over a period of years and which include ratoon canes as well as plants. Yield data for two preliminary experiments on plant canes in St. Kitts are set out in Table VI.

Table VI.—Effect of spacing distance on yield of plant canes under dry and wet conditions.

Area :	Very dry.	Moderately wet.
Estate :	Canada.	Stapleton.
Variety :	S.C. 12/4.	B.H. 10 (12).
Planted :	6/12/33.	16/1/34.
Reaped :	6/3/35.	2/5/35.
Total Rainfall :	(15 months) 45 inches.	(15½ months) 66 inches.
Layout :	Four 3 × 3 Latin squares.	Three 3 × 3 Latin squares.

Yields of cane in tons per acre.

Spacing distance.	DRY AREA.		WET AREA.	
	Yield.	Gain.	Yield.	Gain.
4½ ft. by 2 ft.	31.80	—	37.64	—
4½ ft. by 3 ft.	34.37	2.57	38.58	0.94
4½ ft. by 4 ft.	36.15	4.35	38.35	0.71

The distance between the rows of cane on all plots in both experiments was maintained constant at 4½ feet. The distance between the plants within the row was varied from two feet to four feet.

One experiment was laid down on a very dry area and the other on a moderately wet area. Both areas were given to the acre a dressing of about 25 tons of pen manure before planting and a late dressing of three cwts. of sulphate of ammonia. The dry area was given an early dressing of one cwt. of sulphate of ammonia and the wet area an early dressing of two cwts. of this manure.

Rainfall (in inches) during the life of the plant cane was as follows :—

Month.	Dry area.	Wet area.	Month.	Dry area.	Wet area.
Dec. 1933	3.25	—			
Jan. 1934	4.70	9.62	Sept. (1934)	3.50	6.62
Feb. ..	0.85	1.91	Oct. ..	1.70	2.96
Mar. ..	2.17	5.07	Nov. ..	9.50	11.23
April ..	0.80	0.47	Dec. ..	4.15	5.52
May ..	1.30	1.44	Jan. (1935)	1.93	3.27
June ..	1.94	2.77	Feb. ..	1.15	1.27
July ..	4.25	6.03	Mar. ..	—	0.52
Aug. ..	3.45	7.10	April ..	—	0.59
			Total ..	44.64	66.39

Dry Area.

The monthly rainfall exceeded 3½ inches only on four occasions. When account is taken of the lightness in texture and of the porosity of the soils of St. Kitts it will be realised that the moisture status of the plots must have been very low during the greater part of the life of the plants.

On the dry area differences in yield of plant canes greater than 2.81 tons and 3.90 tons might be due to chance less than once in 20 times and once in 100 times, respectively.

This experiment is of extreme importance, for it gives practical illustration to the disadvantages which can result from planting too closely on light soils under conditions of low rainfall. As the distance between the plants in the row is lessened below four feet the yield of cane becomes significantly and seriously smaller. With plants two feet apart in the row, yield is 4.35 tons less than with plants four feet apart.

The results of a similar experiment on a low rainfall and less fertile area in Antigua have been published elsewhere (3).

Wet Area.

Any differences in yield on the wet area cannot be ascribed with reasonable certainty as due to variation in spacing distance. Even under conditions of moderately heavy rainfall it appears that no gain in yield of plant canes may result from planting closer than four feet in the row *if the rows are not more than 4½ feet apart.*

The results of an earlier trial on the relationship between spacing distance and yield on an area of heavier rainfall has been published in the Annual Reports on the Agricultural Department (5).

The data obtained make obvious the need on both dry and wet areas for other experiments of a similar nature in which there are included spacing distances wider than four feet in the row, or, alternatively, in which the distance between the rows is increased beyond 4½ feet. The effect of manurial treatment in relation to spacing distance also requires investigation.

[*The preliminary information obtained from the manurial and mulching experiments will be discussed in the next issue.*]

DISEASES AND PESTS OF TOMATOES IN BERMUDA.

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Introduction.

Accounts have been published of the diseases and pests of tomatoes in several of the islands of the West Atlantic Ocean. Briant (2) in 1932 described fully the troubles affecting the crop in Trinidad, while Hansford (9) has dealt with the diseases occurring in Jamaica, Wilson (16) the pests in the Virgin Islands, and Wolcott (17) those in other of the West Indian Islands. No full records of diseases and pests found in the Bahamas and Bermudas seem to exist although these islands are amongst the largest producers of tomatoes in the Caribbean area. It is hoped that this account of the troubles encountered in the Bermudian crop may be not merely of local interest but also of some value in the more northerly groups of islands, and that, added to the papers already published, it may help in the painting of a complete picture of the chief causes of loss in the tomato crop throughout the area.

The Tomato Crop in Bermuda.

The tomato crop occupies an important place in Bermudian agriculture. Tomatoes are grown for local consumption almost throughout the year and are exported in quantity during May, June and the early part of July, finding a sale in Eastern Canada between the close of the crop from the Bahamas and the opening of the domestic season.

Two varieties of tomato are grown for export, Bonny Best and Break o' Day, the seed being obtained almost entirely from seedsmen in the United States. Seedlings grown in special beds are planted in the fields when nine to twelve inches high. In a few cases the plants are tied to rods and all side-shoots nipped off, but this method calls for much labour and is too expensive to be profitable when a large area is planted. More commonly the vines are bushed with dead brushwood so that the fruit is kept off the earth, and perhaps most commonly the vines are given no support and are allowed to trail over the ground. While the last method calls for the least labour and expense, it is accompanied by the greatest loss of fruit through injury, and there is cause for believing that the extra expense involved in bushing the plants is repaid by the greater yield of sound fruit harvested. Fruit which is intended for shipment is picked when full-grown but still green, the aim being to have it turning colour when landed in Canada.

Nearly all of the tomatoes for export are brought by the growers to be graded and packed at the Government Packing-houses as described by McCallan (11, 14). The quantity exported in the season May to July, 1933, amounted to 68,326 crates of 20 lbs., of which 67,183 crates, or 98 per cent., were Government-packed.

On the grading machine the tomatoes pass along a sorting table fitted with revolving rollers, by means of which the fruit is kept rotating as it moves along under the eyes of two or three men whose duty it is to pick out all that show blemish or injury and return it to the reject-box. Examination of such rejected fruit provides a convenient method of determining what diseases and pests are causing trouble at any time, though it cannot be relied on to give an accurate measure of the relative importance of the different types of damage owing to the fact that most growers have already rejected a quantity of injured fruit at the time of picking. When observations on the rejects were started in 1932, several types of injury were found of which the causes were not known, and the investigation of their nature then commenced was later extended to form a full survey of the diseases and pests causing injury.

Diseases and Pests.

The tomato crop is subject to loss from a wide range of diseases and pests, the loss depending to a great extent on the time of year and the existing weather conditions. The fact that the main crop of tomatoes frequently follows a crop of potatoes, and indeed that the tomato seedlings are often planted in rows through the potato fields a few weeks before the potatoes are dug, has an important bearing on the occurrence of some pests which are common to the two hosts.

In this survey of injuries to the tomato crop it has been found convenient to group them according to the type of damage done rather than according to the nature of the organism causing the injury. Accordingly the organisms attacking the base of the plant are considered together, and similarly those causing injury to stem and leaf, and those damaging the fruit. The organisms calling for chief mention are the following:

(i) Affecting roots and base of stem:

Fungi, &c.	*Insects.*
Fusarium lycopersici, Sacc.	Noctuidae.

(ii) Attacking stems and leaves:

Septoria lycopersici, Speg.	*Psara periusalis*, Wlk.
Cladosporium fulvum, Cke.	
Sclerotinia sclerotiorum (Lib.) de Bary.	

(iii) Affecting the fruit:

Bacterium vesicatorium, Doidge.	*Phthorimaea operculella*, Zell.
Rhizoctonia solani, Kuhn	Noctuidae.
Phoma destructiva, (Plowr.) Jamieson.	*Nezara viridula*, F.
Phytophthora infestans, (Mont.) de Bary.	
Non-parasitic causes.	

It will be noted that virus organisms find no place in this list, since up to the present time they have not been conspicuous on tomatoes in Bermuda, and no serious damage caused by a disease of this type has yet been recorded.

I. Injuries to the Base of the Plant.

Fusarium Wilt.

Wilt diseases are rarely found during the main growing season, but heavy loss from Fusarium Wilt (due to *F. lycopersici*, Sacc.) sometimes occurs in fields of tomatoes grown between the months of July and December for the local market. In extreme cases a high proportion of the plants may show signs of infection. There seems little doubt that the causal fungus is commonly present in the soil but is only able seriously to infect plants which make their early growth during the warmer weather. Clayton (5) in his experiments with a strain from Indiana has shown that symptoms of attack are produced at soil temperatures between 68°F and 93°F. with an optimum between 77°F and 88°F. While no records are available as to mean temperatures of the soil in Bermuda, the air temperature on an average day in June and in October rises approximately to 74°F in the shade while in the intervening months it is slightly higher, with a mean daily maximum of 80°F in the shade in August.

The symptoms of this disease are fully described in Briant's paper (2). In severe cases they consist of a yellowing of the leaves and later a wilting of the shoot, accompanied by brownish discoloration of the vascular bundles towards the base of the plant. Signs of disease usually become apparent about the time when the plant is beginning to bear fruit.

There is distinct evidence of a difference in susceptibility to this disease between the two varieties commonly grown in Bermuda, Bonny Best suffering to a greater extent than Break o'Day.

Pests which cause minor trouble by attacking the base of the plant include various cutworms, or larvae of Noctuidae, which will come in for later mention in connection with injury to the fruit.

II. Injuries to the Stem and Leaf.

Septoria Blight.

Fungous diseases of the foliage include Septoria Blight, due to *S. lycopersici*, Speg., which is probably the most destructive disease of tomatoes in Bermuda. It occurs at all seasons of the year and is so commonly present that spraying with Bordeaux or Burgundy Mixture is done as a routine measure by most of the growers. In cases of severe attack spraying may give only partial control. On the whole, this blight is more troublesome in winter and spring than in summer, probably because in the warmer weather the host-plant makes faster growth and is not so readily checked by disease.

The Septoria disease is widely distributed through many countries where tomatoes are grown, and it has been fully described by Briant (2) and other workers. In Bermuda the rather angular, greyish-brown spots, marked with minute black dots where the pycnidia are formed, enable it readily to be recognised.

Leaf Mould.

The Leaf Mould disease due to *Cladosporium fulvum*, Cke. is of much less importance in the main growing season than in the autumn and winter months when it may occur in serious form. Even at these seasons however it is not regularly present, and its incidence appears to be greatly affected by weather conditions. It can be easily distinguished by the appearance of the brown fungous growth on the lower surface of the leaves which is usually accompanied by a conspicuous yellowing of the upper surface. Attack is not often sufficiently serious to call for active control measures, but the use of copper sprays and dusts against Septoria blight no doubt helps to check this disease also.

Sclerotinia Disease.

The fungus *Sclerotinia sclerotiorum*, (Lib.) de Bary attacks a wide range of vegetables during the winter and spring months, heavy loss being caused by rotting of carrots and celery during transit to the Canadian market, while, in the field, lettuce is very commonly destroyed and the cabbage and tomato crops less frequently. Various weeds and many garden plants also are attacked, so that the fungus is very abundant in Bermudian soils. As many as five hundred of the black sclerotia have been counted on the ground where a single cabbage head had been rotted by the fungus, and these sclerotia appear to germinate and give rise to apothecia freely during wet weather between December and March.

All the evidence indicates that infection of the tomato plant is not through the soil but is aerial, and indeed attack frequently commences on staked plants at a height of four feet and more from the ground. In such cases it presumably arises through infection of a leaf by an ascospore. Infection by this means was reproduced under artificial conditions in the greenhouse. An apothecium was placed in damp sand and, when heavy discharge of spores was found to be occurring, it was transferred to within half an inch of the under side of a leaflet, in such a way that some of the ascospores were shot off on to it. Infection was found to follow when the leaf was kept in a very moist atmosphere but not otherwise. Infection was also caused by placing on the leaflet a small portion of an agar culture of the fungus, but this again was only successful under very damp conditions.

The first sign of attack on a leaf is a brown discoloration which rapidly spreads inwards, especially along the veins to the mid-rib. Thence the rotting spreads to the adjoining leaflets and down the petiole to the stem. Here a whitish dead area is formed which quickly extends both up and down the stem, and may also girdle it, in which case the distal part of the plant wilts. Black sclerotia are formed inside the hollow stems, and under moist conditions white mycelial tufts and later black sclerotia on the surface of the dead tissues. As the fungus travels along the stem, it passes into leaf-petioles and fruiting-spurs,

and also into any other stems and leaves which may be in contact with the diseased one. The fruit becomes infected through the stalk and turns a greyish-brown colour, white mycelial growth and very large sclerotia often being formed on the surface, especially at the stem end. When the plants are bushed and forming a tangle, the disease may spread very rapidly along the row, but when they are trained up stakes, much less spread is possible from plant to plant. This disease is only seen in the cool winter months at which season the growing of tomatoes on stakes is recommended.

Leaf-Folder.

In some seasons the foliage is badly attacked by Lepidopterous larvae, locally known as fireworms, of which the most conspicuous is the Pyralid *Psara periusalis*, Wlk. The common name of leaf-folder is derived from the habit which the larva has of sheltering on the under side of the leaf and of folding over and stitching down the edge of the leaf or of part of another leaf to give it protection. The method of feeding is typical, the leaf being frequently gnawed from the under side and only the transparent epidermis left.

The larva reaches a length of three-quarters of an inch and varies in colour from yellowish-green to olive-green with red markings on the back. The head capsule is brown with a dark spot on each side, and the first thoracic segment has two dark spots dorsally. The moth has a wing-spread of nearly one inch, the length of body being barely half an inch. The dorsal surface of the body is dark fawn-coloured, but the ventral is much lighter. The wings are fawn-coloured or purplish-brown with a lighter margin, and the forewings are crossed transversely by three wavy lines of darker colour, the hindwings by one.

The leaf-folder has a number of host-plants, most of which are of the Family Solanaceae. Crops on which it is destructive include tomatoes, potatoes, and egg-plants, while ornamental Nicotianas in the garden are badly attacked, and various weeds such as *Solanum nigrum*. Injury is chiefly to the foliage, but young tomato fruits are eaten by the larvae. This pest is recorded by Wilson (16) as occurring in the Virgin Islands and Porto Rico as well as in the southern part of the United States and in South America.

On the tomato plant damage is often sufficiently severe to necessitate control measures, and most growers incorporate arsenate of lead or Paris green in the customary Bordeaux spray against blight while the plants are young. An effective insecticide which could safely be recommended for use after the fruit has formed would be an advantage, but in general it would appear to be the case that, if the plants are kept free from this pest by arsenical spraying up to the time of flowering, it is unlikely to multiply to such an extent during the later life of the crop as to cause serious loss.

Pests of Minor Importance on the Foliage.

The southern tobacco-worm, *Protoparce* (*Phlegethontius*) *sexta*, Joh., though rarely occurring in any quantity is worthy of mention since a few of the larvae, which attain a length of three or four inches, can do a noticeable amount of damage in a short time. The tobacco flea-beetle, *Epitrix parvula*, Fab., is very commonly present but seldom causes much damage, and the same is true of the little black Capsid bug, *Halticus citri*, Reut., which produces pale stipple-marks on the leaves. The leaf-hopper, *Empoasca fabae*, Harr., the whitefly, *Trialeurodes vaporariorum*, Westw., and a leaf-miner which has not been identified, are also found abundantly on the foliage.

In a trial of different varieties of tomato made at the Agricultural Station in 1934, several plants of Best of All remained dwarfed and the leaves failed to develop properly, vaguely resembling a stag's horns in outline, with a yellow colour and rather oily appearance. Such plants were found to be swarming with a very small mite which has been identified as *Tarsonemus translucens*, Green. Some of the affected plants which were given a heavy application of sulphur dust recovered completely in a short time, while untreated plants remained dwarfed and produced no fruit of any size.

III. Injuries to the Fruit.

Loss of fruit is often heavy from injuries of different kinds, some of which are caused by living organisms. In the main crop-season, damage by insect pests, and in particular by the potato tuber worm and by various cutworms, tends to be more severe than fungal disorders, but recently a bacterial spotting has come into prominence. In the winter months on the other hand, fungous diseases often cause heavy damage.

Bacterial Spotting.

Spotting of the fruit has been noticed to a small extent since 1932, but it was not till 1935 that serious loss from this cause occurred in the main crop. In this season the crop experienced much rainy and cloudy weather during its early growth and while the fruit was forming, and as the fruit increased in size a high proportion showed spotting. In a number of fields half the fruit that was picked had to be thrown away as unfit for shipping. At the Packing-houses it was found impracticable to reject every fruit which showed infection, so that the quality of the crop as a whole was of a lower standard than usual, a fact which did not escape notice in Canada.

The most noticeable signs of disease are the distinct black scabby spots which occur mostly in groups or distributed over one side of the fruit, less commonly all over it. The spots are at first slightly raised above the surface of the fruit, but later on, through its continued growth, they may become sunken. As a rule in the variety Bonny Best they are very small, about one-twentieth of an inch in diameter, but sometimes they grow considerably larger and in the variety Break o' Day individual spots may be fully one quarter

of an inch wide. Injury is confined to the skin of the tomato, and the damage results entirely from the bad appearance given to the fruit, rendering it unfit for sale. (Fig. 1.)

At first the presence of pathogenic bacteria was not detected in the scabby tissue, and, as in some cases the spots appeared to be spaced in definite lines or groups, the damage was suspected of being due to the feeding of sucking insects. Accordingly various species of bugs found on tomato plants were collected, and each was tested by placing a few individuals in a glass tube, of which one end was covered by cheese-cloth while the other rested against a young tomato fruit. Of several species tested in this way, including *Nezara viridula*, *Halticus citri*, *Lygus pratensis*, *Trialeurodes vaporariorum*, and *Empoasca fabae*, the first two were the only ones found to feed and to survive on the fruit for any length of time. In neither case did the wounds made in feeding resemble the scabby spots of the disease under investigation.

Later, no difficulty was experienced in isolating a bacterium which proved to be pathogenic. This was found to be rod-like, with one polar flagellum. On potato-dextrose-peptone agar it formed a thin yellow colony, while on sterilised potato chunks a very dense growth of deep yellow colour was made. From these characteristics there appears to be no doubt that the organism is identical with *Bacterium vesicatorium*, Doidge, as described in papers by Gardner and Kendrick (6, 7). The spots seen under Bermudian conditions are usually smaller than those illustrated by these workers, and indeed show greater resemblance to the Bacterial Speck which has recently been described by Bryan (3). It is possible that this disease also is present though so far no pathogenic green fluorescent organism resembling *Bacterium punctulans*, Bryan, has been isolated.

Infection of young tomato fruits in the field was readily obtained. One or two small fruits in each of several trusses were inoculated on 17th June by wiping them with cotton wool which had been dipped in a suspension of the bacteria in water, while other fruits in the truss served as controls being wiped with cotton wool which had been dipped in water. Some of the trusses were enclosed in paper bags in order to preserve a moist atmosphere round them and others were exposed to the air, but the inoculations were equally successful in each case. By 29th June, twelve days later, small black spots were distinctly to be seen on most of the inoculated fruits, and by 5th July, the spots had increased in size and were obvious on eighteen out of the twenty-one fruits inoculated. The controls remained consistently healthy during that time.

It has been shown by Gardner and Kendrick (6) that *Bacterium vesicatorium* may occur on commercial seed and may cause a spotting of the leaves of seedlings and mature plants in addition to the symptoms on the fruit, but foliage infection has not been noticed in Bermuda, being no doubt masked by the ubiquitous Septoria blight. They have also shown that the seed may be effectively disinfected if it is soaked for five minutes in a solution of one part by weight of mercuric chloride in 3,000 parts of water, followed by rinsing in fresh water and drying. This treatment, in addition to general sanitary measures, is now being recommended in Bermuda.

Brown-rot.

The only disease of the fruit due to a fungal organism occurring to any significant extent during the main crop season is Brown-rot caused by *Rhizoctonia solani*, Kuhn. According to Ramsey and Bailey (15), this disease is responsible in the southern United States for great losses in the field and during shipment and marketing, but in Bermuda loss from this cause is seldom great. It occurs chiefly if not entirely on fruit which has rested on the ground, and is therefore only of consequence in plantings where neither staking nor adequate bushing is done. The rot appears as a circular dull brown spot with darker zonations, usually starting towards the blossom-end on the fruit and gradually extending.

From diseased fruits the fungus was isolated without difficulty and its pathogenicity tested. In one experiment, an agar culture bearing vigorous growth of the fungus was mixed with soil in a large flower pot and three sound green tomatoes were allowed to rest on it, two others being placed on uninoculated soil from the same source. They were kept under damp conditions in the greenhouse for five days, when all three fruits on the inoculated soil showed distinct brown-rot at the area of contact while the control ones showed no sign of attack.

Phoma Rot.

In the cooler months of the year heavy loss is often caused by the fungus *Phoma destructiva*, (Plowr.) C. O. Jamieson, which produces a rot of the ripening fruit. The damage is easily recognisable, consisting of brown watery-looking depressed spots which rapidly increase in diameter and which soon bear numerous black pycnidia.

Both Jamieson (10) and Briant (2) have shown that *Phoma destructiva* is a wound parasite only, making its entry into the fruit through bruises and other injuries. At the same time, under abnormal circumstances in Bermuda it may find means of entry so readily that sound fruit is hardly to be obtained. In one case which was investigated, the grower was picking fruit for the local market when full and green or just turning, and was storing it in a barn till fully ripe. During ripening loss from this fungus proved so heavy that only a few fruits were saved. It was his custom after picking to wipe each fruit clean with a cloth, and the suggestion was made that this cloth was contaminated with spores of the fungus and that in the process of wiping the fruit received minute injuries which were sufficient to permit of infection.

Under normal circumstances regular spraying with Bordeaux mixture, aided by the removal of diseased fruit from the field, may be expected to give adequate control.

DISEASES AND PESTS OF TOMATOES IN BERMUDA.

FIG. 1.—BACTERIAL SPOT.—*Fruit on right inoculated 19 days previously with Bacterium vesicatorium. Fruit on left not inoculated.*

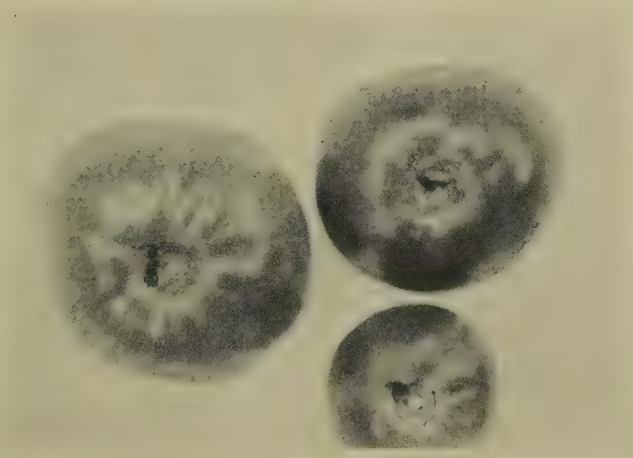

FIG. 2.—ATTACK BY *Phthorimaea operculella.—Entry holes of the tuber-worm marked by heaps of frass at the stem-end of the fruit.*

Phytophthora Rot.

A third fruit-rot has been seen during wet weather in winter, which starts as a brown indentation resembling a bruise on the green fruit usually near the stem-end, and this spreads and darkens till the whole fruit is brown and wrinkled. A species of Phytophthora resembling *P. infestans*, (Mont.) de Bary has been found sporulating on diseased fruits. When diseased tissue of tomato was placed on a wounded potato kept under damp conditions, a rot similar in appearance to the tuber-rot caused by *P. infestans* was produced, and in these circumstances it seems safe to refer to the fungus on the tomato as this species. It is of interest to note that in the case investigated the foliage showed none of the blighting commonly caused by this fungus on potato plants during the winter months.

Leak.

The condition known as Leak or Bacterial Rotting generally follows any insect wound or mechanical injury to the fruit during the warmer part of the year. This seems to be identical with the trouble in Trinidad described by Briant (2), which he suggests is due to *Bacillus aroideae*, Towns. On the green tomato the rot appears as a dark-green water-soaked spot which extends rapidly so that the fruit is soon converted into a watery bag. In time the skin leaks or bursts and the evil-smelling liquid spreads around. The appearance of a crate of tomatoes may readily be spoilt by the presence of one leaky fruit, although the actual rotting does not normally spread from an infected fruit to its neighbours in the crate.

The view of Briant that this bacterial rot follows only after injuries received by the fruit would appear to be borne out by its occurrence in Bermuda, and every care is desirable in growing and handling the fruit to ensure that injury is prevented so far as is possible, and in packing that only sound fruit is included.

Potato Tuber Moth.

In most years more fruit is destroyed by attack of the potato tuber worm than by that of any other single organism. This is the larva of the Gelechiid moth, *Phthorimaea operculella*, Zell., which damages the fruit by burrowing through the core or through the tissue just under the skin of the fruit. Entry is usually made under the calyx, or less commonly at the area of contact between two fruits, and the entry-hole, which is frequently covered by a membrane of silk, is conspicuous from the heap of black frass outside it. (*See* Fig. 2 and Table I.). It is rare to find more than one larva in a tomato fruit, and as a rule the larva does not pass from one fruit to another, and so is commonly to be found in the tunnels it has made, which ramify through the solid tissue. Occasionally the pupa is found near the mouth of the tunnel but more often the larva emerges before pupating.

The fully-grown larva is half an inch long, and is of a greenish-grey colour with a more or less pronounced pink tinge on the dorsum. The head is dark brown, and the cervical plate and thoracic legs are black. The larva is very active and wriggles convulsively when touched. The pupa is at first green but soon changes to a brown colour, and is enclosed in a silky cocoon in which are incorporated particles of the surrounding material. The moth is small with a wing-expanse of little more than half an inch. The wings are of a brownish-grey colour with darker and lighter mottlings, while the body, head, and legs are of a light grey. A full description of all stages of this insect has been made by Graf (8).

This pest occurs in many tropical and sub-tropical countries, and in the Caribbean area it has been recorded from Haiti, the Canal Zone, Mexico, and the Southern United States. It was first noticed in Bermuda during the summer of 1931 when it appeared amongst potatoes stored in a barn. In the following season the larvae were found abundantly in tomatoes as well as in stored potatoes. Although *P. operculella* has been recorded as infesting tomato fruits elsewhere, in Cyprus by Morris (13) and in California by Campbell and Elmore (4), it does not appear to be a major pest of this crop except in Bermuda. Ballou (1) describes its attacks on the fruit of the tomato as rare. Although it is commonly found mining the leaves of the potato in Bermuda, it has so far been found only once in the leaf of a tomato in the field. It is a frequent miner of the leaves of the egg-plant and of *Nicotiana sanderae*, and has been taken both in the leaves and in the fruit of the common weed *Solanum nigrum*.

Much of the main tomato crop is grown on land from which potatoes have just been dug, and as a result potato culls are commonly to be seen lying on the ground amongst the tomato plants. Such exposed potato tubers are greatly subject to attack by the tuber worm and accordingly there is good opportunity for heavy infestation of the neighbouring tomatoes. At summer temperatures the life-cycle of the insect on potato tubers in the laboratory was completed in twenty-three days.

Larvae in tomato fruits and in potato leaves are very frequently parasitised by the Ichneumonid *Angitia blackburni*, Cam., whereas most larvae in potato tubers escape this danger. As the tuber-moth is a recent arrival in Bermuda, it seems possible that a state of equilibrium may not have been reached and that parasitism may yet exert a greater check.

Control of this pest is difficult but some relief can be obtained by sanitary measures, such as the careful clearing of all potato culls from the field. A spray mixture containing arsenate of lead (up to 1 lb. in 20 gals.) may be used on the young plants, but should be discontinued before picking of the fruit is commenced.

Cutworms.

In every picking of fruit it is customary to find a number showing clean circular wounds or cavities in the skin and in the flesh. Damage on this account is often very heavy especially on tomatoes touching the ground or situated near the base of the plant. It appears to be caused by cutworms or Noctuid larvae which have occasionally been taken in the act of gnawing the fruit. At least four species have been found in tomato fruits but only two have been successfully reared to maturity and identified, namely the Corn Earworm, *Heliothis obsoleta*, F., and the Cutworm, *Prodenia ornithogalli*, Guen. Several other pests including snails, wood-lice, millipedes, and wireworms were caged along with green tomato fruits, but none was found to damage the fruit unless it had previously been wounded.

Cutworms, in addition to damaging the fruits, may cause destruction at an earlier stage by gnawing the stem of young plants in the seed-bed and when newly planted out. A certain degree of control is given by baits and sprays containing arsenicals.

The Green Plant-Bug.

The tomato is one of the host-plants of the bug *Nezara viridula*, L., and in the summer months fruits which have been damaged by its feeding are not unusually found. The injury may be described as small irregularly-shaped, light-coloured areas in the fruit, the skin at these lighter spots often being slightly sunken, with a black dot in the centre. The flesh below has the appearance of containing air-spaces instead of being saturated with liquid as if it had been sucked dry by the mouth-parts of the insect.

This bug is widely distributed through the warmer parts of the earth, and in some countries, such as Western Australia, according to Newman and O'Connor (14), it appears to be a more destructive pest than it has proved in Bermuda where the damage has so far not been sufficiently great to call for control measures.

Non-Parasitic Diseases.

Three disorders of the fruit due to unfavourable condition of the weather remain to be mentioned. Whenever dry weather prevails for any length of time, Blossom-end Rot begins to appear, and but for the fact that it is not usual for several days to pass without a shower there is little doubt that this disease might be very destructive in view of the porous and dry nature of the limestone soil of Bermuda. As a rule it occurs only to slight extent, at first being seen as small brown blotches which coalesce to form an area of discoloration at the blossom-end of the fruit. This area may later become sunken and black in colour. The disorder assumed serious proportions in a planting of tomatoes at the Agricultural Station in the autumn of 1934. In this field the plants made splendid vegetative growth and set a large quantity of fruit, but a drought occurred as the fruit was filling and as a result the greater part of the crop was lost through Blossom-end Rot.

A wet spell following dry weather frequently results in loss of fruit through Cracking or Splitting of the skin. It is believed that this disorder as well as the previous one may be alleviated if the ground is mulched or kept well cultivated during dry weather.

Sunscald or Sunburn occurs commonly towards the close of the main growing-season when the sun becomes hot and the foliage sparse. Under these conditions there may occur on the exposed face of the fruit a whitish area, generally about an inch across, later becoming sunken or wrinkled.

Other Causes of Loss.

It is necessary that tomatoes packed at the Government Packing-houses should conform so far as is possible to a fixed standard of appearance and state of maturity, and accordingly fruit is rejected which, though not suffering from attack of disease or pest, is nevertheless undesirable in some other respect. Fruit for example which is picked immature, having a dull-green appearance, is rejected because it is unlikely ever to ripen, while on the other hand fruit which is turning ripe and soft is also deemed unfit to pack since there is every chance of its being over-ripe before it reaches the Canadian market. Many fruits are rejected because they are too small, and others because they are mis-shapen and deformed. A curious malformation occasionally seen is in the shape of a sharp protuberance or beak in the side of the tomato, and more common is an ugly "eye" or scar at the blossom-end. Many tomatoes receive bruises or scars through growing in contact with a stem or by rubbing in the wind against their supporting stakes or bushes, as well as in the processes of picking and conveying to the Packing-houses.

The following table based on counts of fruit in the reject-boxes gives some idea of the relative importance of such causes of loss and of some of the major diseases and pests. On four days during the packing-season of 1934, approximately a hundred rejected fruits were taken at random from each of three or four boxes belonging to different growers, and they were examined and placed in groups according to the cause of their rejection and afterwards the number in each group was counted. As the total number of fruits examined on each date differed, for convenience of comparison the amount of each type of injury is expressed as the average number of affected fruits found amongst one hundred rejected tomatoes.

TABLE I.—*Table showing causes of Rejection of a Mean Sample of* 100 *Tomatoes on each of Four Days during the packing-season.*

Date 1934.	Bruises or Scars.	Too small. Unripe.	Over-ripe.	Mis-shapen.	Non-Parasitic Diseases.	Phthorimaea	Cut-worm.	Bact. spot.	Other Pests or Diseases.
18 May	24	30	3	14	—	7	18	1	3
11 June	20	9	—	5	—	2	37	25	2
28 June	18	4	3	2	36	18	18	—	2
3 July	17	20	3	7	13	17	19	1	3

Table 1 indicates the steady loss that occurs from bruising of the fruit either on the vine or after picking, and the common fault of picking immature fruit at the start of the season. The weather in the month of June, 1934, was dry until the third week when there was heavy rain, and the crop suffered from non-parasitic diseases such as Cracking and Sunburn. Except for a severe attack early in June, bacterial spot was scarce during that season.

Controlling Factors.

(A) The Weather.

In surveying the occurrence of the various pests and diseases at different seasons of the year, one can hardly fail to be struck by the powerful influence exerted by predisposing factors several of which, such as temperature, rainfall, wind, and amount of sun, may conveniently be included in the general term of 'the weather'. The weather obviously has a dual effect on the yield, affecting firstly the host-plant and secondly the parasite or the attack of the parasite on the host-plant. The direct action of unfavourable weather on the tomato crop may cause greater destruction than all the diseases and pests put together, since a gale of wind or a long drought may utterly spoil the crop. But the effect of weather on the incidence of diseases and pests is also very apparent, and conspicuous differences occur in the types and amount of injury found during different seasons of the year and in their relative importance during the corresponding seasons of different years. In the cooler months of winter for instance, certain fungal diseases occur which are never seen in summer, while on the other hand several of the insect pests, such as Phthorimaea, which are common in the summer do not appear in the winter. Again the abnormally wet weather in the early summer of 1935 led to an epidemic of bacterial spot of unprecedented severity in the main crop, and promoted this disease from its customary position of second importance to the top place as chief cause of loss in that crop. Accordingly a mere catalogue of the diseases and pests which may occur is insufficient unless the controlling influence of weather is adequately stressed.

A comparison of injuries to tomatoes recorded for Trinidad by Briant and those described here for Bermuda will show few diseases and no pests that are common to the two places, and this is doubtless due in part to the controlling effect of different climatic conditions in the two areas. The Bermudian list, as might be expected from the geographical position, agrees more nearly with that of some tomato growing areas on the mainland of North America.

(B) The Grower.

The amount of loss from pest and disease, while largely governed by conditions of the weather, is also dependent upon the grower and his land, and the inspectors at the Packing-houses speedily learn which growers generally send good stuff, and which may be expected to send produce that is mediocre or bad. The differences are partly accounted for by the fact that some growers are more scrupulous than others in rejecting damaged fruit at the time of picking, but they are also due to variations in the amount of loss from diseases and pests suffered by different growers. The care or lack of care taken in keeping the land in good heart, in cultivating the crop, in bushing or staking, and in spraying, may all affect the loss from disease and pest. As previously suggested, the severity of attack by *Phthorimaea operculella* is probably bound up with the practice followed by some growers of planting tomatoes directly after potatoes.

The ultimate aim of the grower is of course not to grow a crop which is free from diseases and pests, but to grow the maximum quantity of sound fruit at the minimum trouble and expense. He aims not at growing perfect fruit but at growing a paying crop, and so he has to decide for himself whether the loss due to a particular cause is sufficiently heavy to justify the expense of the necessary control measures. As a general conclusion, it may be stated that the loss caused by some of the major pests and diseases appears to be inadequately realised by most of the growers in Bermuda, and that increased measures for their control, if properly directed, would probably be amply repaid by improved value of the yield.

Summary.

1. An account is given of diseases and pests attacking the tomato crop in Bermuda.

2. These differ largely from troubles recorded in the West Indian islands, but agree more closely with those described from tomato-growing areas in North America.

3. The potato tuber-moth, *Phthorimaea operculella*, which has been described elsewhere as an occasional pest of tomato fruits, may under Bermudian conditions cause heavy loss during the summer months.

4. The state of the weather exerts a powerful influence on the incidence and relative importance of the diseases and pests.

5. It is concluded that further exertions on the part of many growers would be repaid by the improved value of better crops.

Several pests which are mentioned in this paper were kindly identified at the Imperial Institute of Entomology, and the assistance given is gladly acknowledged.

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SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Entrainment in the Multiple Effect Evaporator.—*J. L. Halpin.*

In considering factors leading to the avoidance of entrainment in the m.e. evaporator, the feed inlets should be so placed that there is no risk of the feed short-circuiting to the outlet without passing through the heating tubes; they should also be clear of the tubes near the steam inlet to the calandria or the steam lanes. These are the hottest portions of the calandria; the feed being of higher temperature than the contents of the vessel, it has a tendency to flash and to rise through the tubes at high velocity, the velocity being greatly increased by the higher temperature of the tubes adjacent to the steam entry. Thus, atomized liquor is projected into the vapour space and may be carried out of the vessel with the vapour. Splash guards or baffles should be securely fixed over the inlets to mix the feed with the liquid already in the vessel before it comes into contact with the heating surface.

Sufficient depth between the calandria and the bottom of the vessel is an important factor; indeed, old installations were designed to deliver the feed above the calandria. Unless there is a sufficient depth of liquor below the calandria, the tendency of the incoming feed to flash up the tubes is greatly increased, and particularly is this the case in the final vessel where the temperature difference between contents and the feed may exceed 50°F. Ample height above the calandria is also required, more especially in the last vessel, to give the drops of liquor projected into the vapour space time to fall under the influence of gravity. But such height does not, itself, eliminate entrainment, though it may reduce it.

Yet another factor is the temperature difference between the two final vessels, and occasionally one of 58°F. may be found when the evaporation is carried to 68° to 70° Brix. Under such conditions, a hammering sound may be heard in the lower part of the final vessel, due to the sudden expansion of the hot liquor entering the relatively cooler liquor in the vessel. In extreme cases it may be necessary to introduce the feed through several entry points. An increased heating surface in the final vessel would, of course, reduce, this temperature difference, and a similar result can be obtained where steam is taken from the first or second vessels for use in heating.

High rates of evaporation naturally involve high vapour velocities. With vacua of 26 inches or higher, the increase of vapour volume per unit of weight and consequently vapour velocity is particularly marked. High vacua also increase the volume of vapour for a unit weight and involve higher vapour velocities, the risk of entrainment losses from the earlier vessels of an effet set being low because the vapour volumes per unit of weight are relatively smaller and the vapour velocity lower.

Assume that a quadruple 4,000 sq. ft. of h.s. in each vessel; that the diameter of each is 10 feet; that the steam pressure in the first calandria is 4½ lb. gauge pressure; that the rate of evaporation in each vessel is equal, then for an overall evaporation of 7 lb. of water per sq. ft. per hour, equivalent to an evaporation of 7 7/9 lb. per second from each vessel, the following conditions will prevail:—

Vessel.	Pressure or Vacuum.	Temp. °F.	Volume 7 lb. water in cub. ft.	Vapour Velocity ft. per sec.	Temp. difference °F.
1st Calandria	4½ lb.	226	—	—	—
1st Vessel ..	1 lb.	215	196	2.50	11
2nd ,, ..	5 in. vac.	203	235	3.10	12
3rd ,, ..	15 in. vac.	179	399	5.08	24
4th ,, ..	26 in. vac.	126	1,361	17.30	54

Then the volume occupied by 7 7/9 lb. of water vapour at 26 inches vacuum (1,361 cu. ft.) is increased under higher vacua as follows: 26½ in. 1,571 cu. ft., 27 in. 1,805, 27½ in. 2155, 28 in. 2638. —(*Int. Sugar Journal*, Vol. XXXVIII, No. 445. p. 36, 1936.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Derris, Pyrethrum and Nicotine.

Many new developments with these insecticides have occurred. Derris has shown considerable promise in the control of various insects and pests. The finely ground derris powder mixed with water and applied as a spray has given good control of the Mexican bean beetle. A similar spray has also been effective against the pea aphid. By adding sulfonated castor oil to this same derris powder spray it has given effective control of the red spider mite on cucumber and other plants. A dust of derris powder has given good control of the tobacco flea beetle, especially in seed beds where it is a severe pest of the young tobacco plants.

Derris powder sprays have shown some killing action against the Japanese beetle, but more especially a distinct repellent action is exerted. Plants sprayed with a derris powder spray have in this way been protected from the attack of this beetle.

Rotenone and the other crystalline compounds present in derris are apparently not its only toxic constituents. It is probable that the non-crystalline ingredients of derris, such as optically active deguelin, exert an effect. The optically active dehydrodeguelin has been shown to be more toxic than the optically inactive isomer.

Several years ago rotenone was found in the devil's shoestring, *Cracca virginiana*, a weed growing widely in the United States. A recent study of plants of this genus gathered from different parts of the United States has shown that those from Georgia, Texas, and Florida contain the highest content—as much as 1.8 per cent. rotenone—of insect-killing constituents.

Pyrethrum has also received considerable attention. A method has been developed for the isolation of pyrethrin II, which is much more simple and less drastic than any previously used. A simpler method of analysis has also been developed. An interesting experiment illustrating the difference in action of pyrethrum and derris has been reported, using the cabbage worm. Worms fed with pyrethrum powder, embedded in gelatin films, were not affected, but those fed with derris were killed. Worms allowed to crawl over the film pyrethrum but not allowed to eat it were killed but those crawling over the derris film were unharmed. Derris acted as a stomach poison but not as a contact insecticide, whereas the toxic action of pyrethrum was primarily contact and not a stomach poison in this instance.

Anabasine, an alkaloid similar to nicotine in chemical and insecticidal properties, has been found in the leaves and roots of the tree tobacco, *Nicotiana glauca*, of the south-western United States. Anabasine was first prepared synthetically several years ago by chemists in the Department of Agriculture and was later found in a Russian weed, *Anabasis aphylla*.—(*Ind. & Eng. Chem., News Ed.*, Vol. XIII, No. 24, 1935, p. 475.)

The Soap and Detersive Industry. *M. H. Ittner.*

Development of the soap industry was a gradual process. At the beginning of the 19th century most soap was made in the home from fat scraps, using lye recovered from wood ashes. The discovery of a method for making cheap caustic and the concentration of meat packing in a few large plants aided the soap industry. The recovery of glycerin helped reduce the cost of the finished products. Scarcity of fats and high duty necessitated the use of alkaline builders, such as sodium carbonate, silicate or phosphate, which were later found to increase the actual washing value. Various types of aqueous saponification of fats using little or no alkaline or acid catalytic saponifying agent and resulting in fatty acids and glycerol, have commanded the attention of soap and candle makers for more than 75 years, and gradual improvements have rewarded their efforts. The distillation of fatty acids has gradually been improved upon until now there are several systems of obtaining high-grade distilled fatty acids, each system being so satisfactory that its advocates are inclined to ignore the success of others in the same field. The process of saponification is old and is generally looked upon as susceptible of little change or improvement. It has now been found that what might be called "dry saponification" is altogether practicable and that dry fats may be saponified by anhydrous alkaline materials with the aid of dry superheated steam, in the absence of liquid water, giving anhydrous soap and concentrated glycerol; the saponification is rapid and complete, and the recovery of glycerol is complete. Sodium salts of certain organic acids or sulphates of alcohols are being developed for use in place of soaps. They are readily soluble in water and make suds resembling soapsuds. They work in neutral acids or basic solutions, and possess some advantages in cleaning natural silk and preparing fibers for dyeing. They are suitable for use with hard water as no objectionable precipitates are formed. The long-proved value of soap and its low price make it improbable that these new cleansers will displace it for ordinary cleaning. — (*Journal of Chemical Education*, Vol. XII, No. 12, 1935, p. 594.)

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Pigments of Pink Grapefruit.—*M. B. Mattack.*

The dried flesh of the Foster and the Marsh pink grapefruits was extracted with carbon disulphide and after a preliminary purification the pigments were separated and isolated by the Tswett chromatographic method. The separated pigments were identified spectroscopically as *Lycopene* and *B. carotene*. *Lycopene* predominates in Foster and *B. carotene* in the Marsh variety. [*Jr. of Biol. Chem.* Vol. 110, p. 249, 1935. (abst. in *Brit. Chem. Abstr. A*, p. 1040. Aug, 1935).]

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt).

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
2nd January	5	3¾	9	0¾
9th January	5	2¼	9	0¾
16th January	5	0¾	8	10½
23rd January	5	3	8	9¾
30th January	5	3	8	9¾
6th February	5	3	8	9¾
13th February	5	3	8	9¾
(14th *February*, 1935)	4	2¼	7	11¼

The market which at one time showed signs of weakness has rallied into a steadier and more active tone as a result of rather more buying interest, and firmer advices from American markets. Some uncertainty has been introduced in America by the decision of the Supreme Court in Washington which declared the Agricultural Adjustment Act unconstitutional. It is believed, however, that things will follow much the same course as they did last year when the National Recovery Act was declared unconstitutional.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	Pence per lb.
31st December	6 7-16
8th January	6 5-8
15th January	6 11-16
22nd January	6 7-8
29th January	7
5th February	7 1-16
12th February	7 1-4
(13th *February*, 1935)	6 5-16

The market has been very firm and prices have shown a gradually rising tendency. There has been a sustained demand for the article from European and American consumers and the steady upward trend of prices suggests that the restriction scheme is gradually becoming effective. Total consumption in America for 1935 worked out at 497,148 tons compared with 455,997 tons for 1934 or an increase of 41,151 tons equal to nine per cent. Consumption for the year exceeded that for 1929, the previous record year, by 27,000 tons.

* * *

BANANAS.—Demand has seriously been affected by cold and foggy weather and prices, since our last report, have been reduced by £5 per ton to £15 5s. delivered London and £15 nearest Station Provinces. Brazilians are £4 lower at £12 delivered nearest station. (16th January.)

COCOA.—A much firmer tone with increased activity has manifested itself since our last report. This has no doubt been brought about by the inability of manufacturers to purchase cocoa in sufficient quantities, and the fear of inflationary development. Added to this is the fact that in comparison with other commodities cocoa has not risen in value from the low depression levels. Good Fermented Accra is quoted at 23s. 6*d*. c.i.f. Continent and locally $7.40 per fanega is being paid. —(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
27th December	6.41	9.54
3rd January	6.44	9.60
10th January	6.07	9.43
17th January	6.13	9.57
24th January	6.17	9.68
31st January	6.14	9.69
7th February	5.99	—
14th February	6.21	—
(15th *February*, 1935)	7.06	8.80

The market has generally been easier. There has been considerable confusion concerning the position relating to crop control in America as a result of the decision of the Supreme Court of the United States declaring the Agricultural Adjustment Act unconstitutional. It is believed, however, that the Government will bring forward some plan to meet the situation. In the absence of supplies there is no business reported for West Indian Sea Island.

* * *

CITRUS PRODUCTS.—*Lime Oil.*—Handpressed is valued nominally at 35*s*. *ex* wharf. There is more inquiry for Distilled and stocks are decreasing. The last value of 22*s*. 6*d*. is unchanged. *Lime Juice.*—There are buyers of concentrated at £4 15*s*. Raw is attracting more attention and the value is firm at 2*s*. to 2*s*. 6*d*. for good to fine.

* * *

Orange Oil.—Buyers show little interest in West Indian sweet. There are sellers at 6*s*. 6*d*. Bitter is quiet and valued at 6*s*. to 7*s*. per lb.—(*West India Committee Circular*, 16th Jan., 1936.)

* * *

COPRA.—The market has continued firm and West Indian f.m.s. at £15 15*s*., c.i.f. London is £1 higher. (16th January.)